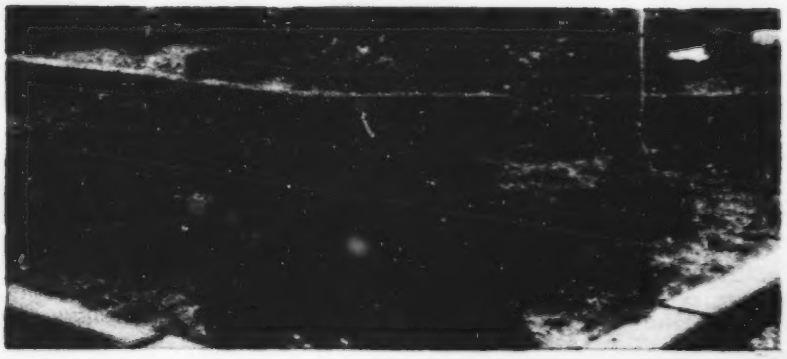
PUBLICATION 383

1985-86 PRODUCTION RECOMMENDATIONS FOR ORNAMENTALS AND TURF

Ministry of Agriculture and Food
ONTARIO
Dennis Timbrell, Minister
Clayton M. Switzer, Deputy Minister



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ONTARIO MINISTRY OF AGRICULTURE AND FOOD
HORTICULTURAL CROP ADVISORS

Counties or Area Served	Name	Address	Phone No.
Eastern Ontario	Steve Rowe	College of Agriculture Technology Kemptville, K0G 1J0	613-258-3411
Prince Edward, Hastings	Jody Bodnar	P.O. Box 470, Picton, K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgway	P.O. Box 340, Trenton, K8V 5R5	613-392-3527
Durham, Victoria	Bev Ells	234 King St. East, Bowmanville, L1C 1P5	416-775-3783
North York (Bradford Marsh Area)	Matt Valk*	Muck Research Station RR 1 Kettleby, L0G 1J0	416-775-3783
Simcoe, Dufferin, Grey	Ken Wilson	P.O. Box 69, Clarksburg, N1H 1J0	519-599-2042
Halton, Peel, North Wentworth	Joe Uyenaka	17 Wilson Drive, Milton, L9T 3J7	416-878-2314
Niagara Peninsula	Burke McNeill Ian Smith	Vineland Station, L0R 2E0	416-562-4142
Norfolk, Brant	Russ Chard	P.O. Box 587, Simcoe, N3Y 4N5	519-426-7120
Oxford, Elgin, Perth Waterloo	Keith Priest	P.O. Box 666, Woodstock, N4S 7Z5	519-537-6623
Lambton, Middlesex, Huron	John Gardner	367 Ridout St. North London, N6A 2P2	519-434-6811
Essex, Kent	Ed Tomecek	College of Agricultural Technology Ridgetown, N0P 2C0	519-674-5456
Essex, Kent	Clem Fisher, Leslie Huffman	Research Station, Harrow, N0R 1G0	519-738-2251
Horticultural Crop Advisor (Potatoes)	Sam Squire	P.O. Box 370, Alliston, L0M 1A0	705-435-5521
Horticultural Crop Advisor (Flowers)	John Hughes	Department of Horticultural Science, University of Guelph, Guelph, N1G 2W1	416-451-5560
Horticultural Crop Advisor (Flowers & Nursery)	Wayne Brown	Vineland Station, L0R 2E0	416-562-4142
Horticultural Crop Advisor (Marketing)	Bob Cobbledick	Vineland Station, L0R 2E0	416-562-4142

PEST MANAGEMENT SPECIALISTS

Durham and Counties Eastward	Cathy McKay	234 King St. East, Bowmanville, L1C 1P5	416-623-3348
York County (Muck Veg. Crops)	Mary Ruth McDonald	Muck Research Station RR 1 Kettleby, L0G 1J0	416-775-4261
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Elgin County West to Essex County	Alison Smith	367 Ridout St. North London, N6A 2P2	519-434-6811
Extension Plant Pathologist	Craig Hunter	P.O. Box 587, Simcoe, N3Y 4N5	519-426-7120

* *Horticultural Research Institute of Ontario staff.*

If a problem arises in connection with special pests, spray mixtures or spraying, and other cultural practices, telephone or write the Horticultural Crop Advisor or Pest Management Specialist serving your area.

Agri-Phones

Georgian Bay	519-599-2915	Milton	416-876-1383	Woodstock	519-537-7161
Kingsville	519-733-3151	Newmarket	416-775-3493	St. Catharines	416-684-6684
Chatham	519-352-0222	Smithfield	613-392-3422	London	519-438-1014
Simcoe	519-426-7810	Vineland	416-562-4345	Bowmanville	416-623-4944

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The pesticide recommendations in this publication are for commercial plantings in Ontario. Home gardeners should use products and methods recommended in Ontario Ministry of Agriculture and Food Publication 64, *1985-86 Insect and Disease Control in the Home Garden.*

ACKNOWLEDGMENTS

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Crop Protection Committee
- Ontario Ornamental Research Committee
- Ontario Soil Management Research Committee

and personnel of:

- Plant Industry Branch, Ontario Ministry of Agriculture and Food
- Ontario Agricultural College, University of Guelph
- Agriculture Canada
- Ontario Ministry of the Environment
- Royal Botanical Gardens
- Ontario Ministry of Natural Resources
- Ontario Ministry of Labour
- Health and Welfare Canada
- Horticultural Research Institute of Ontario

Pesticide products listed in this publication have been reviewed by the Ontario Pesticides Advisory Committee and have been classified under the Pesticides Act.

In this publication most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that in some cases the most effective pesticides are highly toxic.

The effectiveness of pesticides, and plant injury by control chemicals are influenced by the weather and other conditions. Consult the package and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powder (WP and SP) preparations generally are less likely to cause plant injury than liquid concentrate (EC, SC, and F) formulations. A number of brand or trade names of chemicals are used for the convenience of readers. This constitutes neither an endorsement of the product nor a suggestion that similar products are not effective.

ONTARIO MINISTRY OF THE ENVIRONMENT-
PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill & D. Trenholm 7 Overlea Blvd., Don Mills M4H 1A8	416-424-3000 (Ext. 211)
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George Street, N., Peterborough K9J 3G6	705-743-2972
Simcoe, Muskoka	W. Cowie 12 Fairview Road, Barrie L4N 4P3	705-726-1730
West Central Region		
Haldimand, Norfolk, Niagara Hamilton-Wentworth	J. Percy Ont. Gov't Bldg., 119 King St. W., Hamilton L8N 3Z9	416-521-7640
Dufferin, Wellington, Waterloo, Brant	R. Miller Ont. Gov't Bldg., 119 King St. W., Hamilton L8N 3Z9	416-521-7640
Southwestern Region		
Elgin, Middlesex, Oxford	D.C. Morrow & W. Lampman 985 Adelaide Street South, London N6E 1V3	519-681-3600
Essex, Kent, Lambton	H.E. Collins P.O. Box 237, 435 Grand Ave. West, Chatham N7M 5K3	519-352-5107
Bruce, Grey, Huron, Perth	B.T. Lobb 20 King Street, P.O. Box 688 Ont. Ministry of Agr. & Food Bldg., Clinton N0M 1L0	519-482-3248
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon 133 Dalton St., Box 820, Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett Northgate Shopping Centre, 1500 Fisher St., North Bay P1B 2H3	705-476-1001
Cochrane, Timiskaming, Algoma	P. McCubbin 83 Algonquin Blvd. W., Timmins P4N 2R4	705-264-9474
	Sault Ste. Marie	705-949-4640
Northwestern Region		
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Building 435 James St. S., Thunder Bay "F" P7E 6E3	807-475-1305
Head Office		
	Agricultural & Industrial Chemicals Section, 135 St. Clair Avenue West, Suite 100, Toronto, Ontario M4V 1P5	416-965-7048

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from Agricultural & Industrial Chemicals Section, Ministry of the Environment, 135 St. Clair Avenue West, Suite 100, Toronto, Ontario M4V 1P5:

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs

PRECAUTIONS WITH ALL PESTICIDES

1. Always read the label before opening pesticide containers, and follow all precautions and directions.
2. Never smoke, chew tobacco or eat while handling or applying pesticides. **Do not** carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle the concentrate, and when coming in contact with dilute spray i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.
4. Inhalation of spray droplets, dust or fumes should be avoided. Wear a respirator to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. For gases a self-contained breathing apparatus may be required.
5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots. Avoid spilling pesticides on skin or clothing.
6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing spray equipment. Never fill a sprayer directly from a stream, pond, or wells unless the unit is equipped with an anti-backflow device to prevent siphoning.
7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident. You can use this book, see table on page F1.

STORAGE

1. General Storage
   The Ontario Pesticides Act and Regulation 751 require that all pesticides be kept out of reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans, and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage
   Schedule 1, 2, and 5 — pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "Chemical Storage Warning — Authorized Persons Only" in black capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.
2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers. See also OMAF Factsheet, *Farm Storage of Pesticides*, Agdex 607.
3. Post pesticide storage areas with proper notices.
4. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems, affecting humans, domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS AND CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads or outdoor public areas.
2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful — why not use that 3% for the purpose for which it was purchased, i.e., to control the pest.

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the containers directly into the spray tank. This procedure takes less than a minute and results in a rinsed container. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

SPECIAL INSTRUCTIONS

It should be emphasized that all pesticides are toxic and must be handled safely. In addition, a number of pesticides (insecticides, fungicides and herbicides) have major deficiencies in their toxicological information because many tests were conducted by the Industrial Biotest Laboratory (IBT) and some of these were invalid. Replacement studies are currently being conducted by the respective registrants. Those handling and applying these chemicals must pay special attention to the precautions outlined above.

At the time of publication, pesticides included in this publication requiring additional studies are as follows:

CSA Common Name	Trade Name
acephate	Orthene
captan	Captan, Orthocide
endosulfan	Thiodan
metiram	Polyram
oxydemeton-methyl	Metasystox-R

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.
2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove all contaminated clothes, including underclothes, have a bath or shower and put on freshly laundered clothing. Wear freshly laundered clothes each day.
3. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice. (See list page 2).
4. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to hospital immediately. If possible, take the list of common name chemicals, you have been using, with you to the hospital. (See Emergency Procedures for Pesticide Poisoning, page 7).
5. If a well becomes contaminated follow clean up instructions in Ontario Ministry of Agriculture and Food Factsheet *Pesticide Contamination of Farm Water Supply*, Agdex 607.

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. When measuring and mixing pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields.
2. Disposable gloves, aprons, overalls and hat covers are available at reasonable prices from the major safety supply companies.
3. Wash all clothing after use.
4. Wear a chemical respirator with dual cartridges when mixing and applying pesticides. Consult the following chart for proper selection. Never interchange components.

DUAL CHEMICAL CARTRIDGE RESPIRATORS RECOMMENDED FOR OUTDOOR PROTECTION FROM PESTICIDES (LISTED IN NUMERICAL ORDER ACCORDING TO NIOSH APPROVAL NUMBERS)

NIOSH APPROVAL NUMBER	APPROVAL ISSUED TO	RESPIRATOR NO. AND DESCRIPTION	COMPONENT NUMBERS	AVAILABLE FROM
TC-23C-54	Willson	122115 (2 sizes) Half-Face	R21 Cartridges R15 Filters	Safety Supply Canada, Toronto
TC-23C-74	North	7549L 7549M 7549S (3 sizes) Half-Face	N7500-1 Cartridges N7500-23 Filters N7500-27 Filter Cover	Siebe-North Inc., Rexdale Ontario
TC-23C-78	3M	Powered Air Purifier (pesticide) White Cap Helmet Full-face	Cartridges Filters and Hood and Vest Kit	Safety Supply Canada, Toronto
TC-23C-106	American Optical	R4058 R5058 R6058 (3 sizes) Half-Face	R58A Filter Cartridges	AO Safety Products Div. of AOCO, Toronto
TC-23C-117	Scott	Scott Respirator 64-OVP Half-Face (3 sizes)	642-OV Cartridges 642-F Filters	Safety Supply Canada, Toronto
TC-23C-123	3M	8751 Half-Face	Pre-Filter 8752 Retainer 8733	Safety Supply Canada Toronto
TC-23C-124	Safety House	236-G100 F 104 Half Face	G100 Cartridges F 104 Filters	Safety House of Canada, Toronto

NIOSH APPROVAL NUMBER	APPROVAL ISSUED TO	RESPIRATOR NO. AND DESCRIPTION	COMPONENT NUMBERS	AVAILABLE FROM
TC-23C-133	Willson	162115 172115 Full Face	R15 Filters R21 OV Cartridges	Safety Supply of Canada Toronto
TC-23C-148	MSA	460560 (3 sizes) Full-face	464025 Combination Cartridges	MSA of Canada, Downsview Ontario
TC-23C-178	North	75 BP 49L 75 BP 49M (2 sizes) Half-Face	N-7500-21 Cartridges N-7500-23 Filters N-7500-27 Fit Check Filter Back-pack	Siebe-North Inc., Rexdale Ontario
TC-23C-190	North	7649 Neoprene 7649S Silicone Full-face	N-7500-21 Cartridges N-7500-23 Filters N-7500-27 Fit Check Filter Cover	Siebe-North Inc., Rexdale Ontario
TC-23C-202	HSC Corp.	MY 1482 G 3 sizes Half-Face	MYX100G Cartridges MYX102F Filters	Levitt-Safety Ltd., Toronto
TC-23C-224	Scott	Scott Respirator 65-OVP Full-face (2 sizes)	642-OV Cartridges 642-F Filters	Safety Supply Canada, Toronto
TC-23C-238	American Optical	R7058 Full-face	R58A Filters Cartridges	AO Safety Products Div., of AOCO, Toronto
TC-23C-258 TC-23C-54	Willson	S122115 (2 sizes) Silicon Material Rubber Material	R21 Cartridge R15 Filters	Safety Supply Canada Toronto
TC-23C-281	American Optical	R4563 R5563 R6563 (3 sizes)	R563A Filters Cartridges	AO Safety Products Div., of AOCO, Toronto

NIOSH APPROVAL NUMBER	APPROVAL ISSUED TO	RESPIRATOR NO. AND DESCRIPTION	COMPONENT NUMBERS	AVAILABLE FROM
TC-23C-282	American Optical	R7563 Full-face	R563A Filter Cartridges	AO Safety Products Div., of AOCO, Toronto
TC-23C-323	Survivair	2131-00 2231-00 2331-00 (3 sizes) Half-Face	MS100100 Cartridges MS104000 Filters	Levitt-Safety Ltd., Toronto
TC-23C-354	North	10041 Small 10041 Med. Disposable Type	10001 Cart./ facepiece 10056 Filter 10070 Fit Check/ Filter Cover	Siebe-North Inc., Rexdale, Ontario
TC-23C-374	Willson	3021155 Breathing Assist Respirator	R15 Filters R21 OV Cartridges	Safety Supply Canada Toronto
TC-23C-375	Willson	322115 Breathing Assist Respirator	R15 Filters R21 OV Cartridges	Safety Supply Canada Toronto
TC-23C-456	Survivair	3231-00 Full-Face	MS100100 Cartridges MS104000 Filter	Levitt-Safety Limited Toronto, Ont.
TC-23C-482	Racal Airstream	AS10241 Breathe-Easy Turbo Unit (Positive-Pressure)	22-10-29 Cartridge and Filter	Safety Supply Canada Toronto
TC-23C-571	Willson	152115 (Inflatable Seal-all, 3 sizes in one)	R21 Cartridge R15 Filters	Safety Supply Canada Toronto

Additional information on protective equipment may be found in *Personal Protective Equipment for Pesticide Users*, available at offices of the Pesticides Control Service, your pesticide dealer, and offices of the Ontario Ministry of Agriculture and Food.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air-Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Working Conditions

High Concentrations

(a) Use only a self-contained breathing apparatus e.g. Scott's, Air Pak.

(b) High concentration of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as parathion, nicotine and naled (Dibrom):

(i) through fogging machines
(ii) by means of smoke bombs
(iii) as spray applications

In such instances self-contained breathing apparatus is recommended.

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) and fensulfothion (Dasanit 15G) but the wearing of canister gas masks provides protection.

Contact your safety supply company for the proper canister selection.

Other Clothing

When measuring, mixing and applying pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, hat, and protective eyeshields or a full-face mask.

METHYL BROMIDE AND INSECTICIDE SMOKES

A permit issued by the Ontario Ministry of the Environment is necessary to use methyl bromide (MC-2 and MB-C_2). To apply for a permit contact:

Commercial & Agricultural Chemicals Section
Ontario Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5
Telephone: (416) 965-2401

When using methyl bromide or insecticide smoke generators, suitable protective clothing must be worn. After treatment, the greenhouse must be barricaded and warning signs posted. In general, smokes are especially useful for small greenhouses of 930 m^2 or less. Smoke applications are not satisfactory for spot treatment.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The list of pesticides below is one for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum interval is recommended. Minimum reentry time of 48 hours is recommended after using Azinphos-Methyl (Guthion, APM)

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled onto clothing or parts of the body remove clothing including under-garments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from your list mentioned below or use this book for reference.

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Avenue, Toronto M5G 1T7 has physicians available for consultation on first-aid information and advice. They can be contacted between 8:00 a.m. and 5:00 p.m. Monday to Friday. Telephone (416) 965-3610.

RELATIVE HAZARDS TO HUMANS FROM PESTICIDES

Extreme and High Hazards

These pesticides are dangerous if inhaled, swallowed, or allowed to contact skin. A few grams can be fatal. Wear protective clothing (page 4) avoid mixing in windy areas, dispose of containers properly (page 3) and always change clothing and wash immediately after use.

Extreme Hazards	High Hazards
Di-Syston (disulfoton)	DDVP (dichlorvos)
Guthion, APM (azinphos-methyl)	Nicotine (sulfate)
Parathion	Zinc phosphide

Moderate Hazards

These pesticides are dangerous if handled carelessly. Caution is required to insure that they are not taken internally or allowed to contact skin. Wear protective clothing including respirator and goggles when mixing or working with them. Avoid breathing the vapors. Remove clothing and wash after applying these pesticides. Triple rinse and dispose of containers properly (page 3).

Basudin (diazinon)
Captan*
Cygon (dimethoate)
Ethion
Imidan (phosmet)
Lindane
Meta-Systox R (oxydemeton-methyl)
Pirimor (perimicarb)
Thiodan (endosulfan)

*Current studies indicate Captan requires special handling procedures as outlined on the label. Therefore follow directions carefully.

Low Hazards

Pesticides listed in this calendar and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely, if used properly, by following all directions and precautions listed on the label.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should be commenced prior to using these pesticides and not after applications have commenced since the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are:

Organophosphates: acephate, azinophos-methyl, chlorpyrifos, diazinon, dimenthoate, malathion, oxydemeton-methyl, phosmet
Carbamates: carbaryl, perimicarb

WEED CONTROL

For complete weed control recommendations including comprehensive information on chemicals, safety precautions and calibration and care of sprayers, use Ontario Ministry of Agriculture and Food Publication 75, *Guide to Chemical Weed Control.*

Unless otherwise mentioned, the recommendations are intended to apply only to herbicides used with field-grown crops. The use of certain herbicides in greenhouses or cold frames can injure the crop.

Chemical weed control should never be a substitute for good cultural practices. Reduce the spread or increase of weed seeds by cutting or disking weeds before they go to seed. Concentrate on the eradication of persistent perennial weeds by cultural practices. Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Careful shallow cultivation is best. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. **Do not experiment** with chemicals or mixtures which are not recommended.

CAUTION

Spray drift can damage or destroy susceptible crops for a great distance from the sprayer. Use extreme caution when applying hormone-like herbicides (2,4-D, MCPA, etc.) near susceptible plants or crops. These herbicides should only be applied when it is calm (either early morning or late evening) or when a very light wind is blowing away from any susceptible plants. Use low pressures whenever possible as only enough pressure is required (200-250 kPa) to get uniform distribution. High pressures produce many small droplets which drift. **Do not use the same sprayer for applying 2,4-D and similar herbicides as you use to apply insecticides and fungicides.** Drain and wash out the sprayer immediately after use. Do not empty herbicide mixtures or wash water into drainage ditches, streams or ponds or places where the herbicides can be washed into them. Do not mix different herbicides, or herbicides with other pesticides or foliar fertilizers, unless recommended by competent authorities.

MOUSE CONTROL

In September look for signs of mice — fresh grass clippings in runways, droppings, and tunnels. Probably the best bait at present is zinc phosphide-treated cracked corn.

As a supplement to poisoning, remove straw, trash, sod, etc., from around the base of the trees in the fall for at least 60 cm from the trunk.

Baits available

1. Waxed Zinc Phosphide bait — 5.5-11 kg per hectare depending on the severity of infestation. When further mice activity is detected, repeat the treatment when rain is not expected.
2. Ramik Brown — 22 kg per hectare in two applications of 11 kg each. Application can be made 20-40 days apart.
3. Rozol Paraffinized Pellets (0.005% chlorophacinose). Apply at rate of 11 kg per hectare.

Tree Guards

Set wire tree guards of 6 mm mesh galvanized wire around the trunk. Set them about 8 cm deep in a mound of fine crushed stone or sharp cinders. Check the guards each fall to see that they are mouse-tight and free of trash. Tree guards are expecially valuable in protecting young trees for a long period.

A number of other materials are suitable for mouse guards, e.g. heavy aluminum foil. A number of commercial tree guards are available. Do not use tarpaper because it may damage the bark.

Repairing Tree Damage

Regular inspection should be carried out throughout the winter to see if any injury has occurred. Mice work just below the surface of the snow or litter. If a tree has been wholly or partially girdled, it should be given first-aid immediately.

RABBIT CONTROL

Repellents

Rabbit repellents containing thiram appear to be superior to the old rosin-alcohol mixtures. A number of commercial thiram rabbit repellents are available. Consult the directions on the container. Be sure to treat the tree as high as rabbits can reach when standing on deep snow. The repellents may be applied with a small knapsack sprayer or painted on with a brush.

Shooting
Shooting rabbits is an excellent means of keeping the population down. However, it must be done regularly throughout the year because other rabbits soon move into the area. Shooting alone cannot be depended upon to provide adequate control.

Wrapping Young Trees
Wrap sacking about the top and the trunk, above the mouse guard, to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when snow is deep.

Cautions in Handling Poison Baits
All containers used for poison bait should be marked POISON and stored away from children, irresponsible persons, pets and livestock. Baits containing zinc phosphide should not be kept in a building where there are people or animals.

Equipment for mixing and applying poison bait should be kept for that purpose alone.

Wear rubber or other gloves as for hazardous insecticides, and wash after handling poison baits. Do not inhale zinc phosphide dust or fumes.

These baits are recommended for use in commercial nursery plantings only.

Dogs that are enthusiastic mousers should be kept out of the nursery for two or three days to prevent them from catching a large number of dying mice.

PESTICIDE RESISTANCE

Many of the pesticides recommended have a very specific mechanism of action, that is, they act on a single system or site in the organism. These materials should not be used continuously and repeatedly in a season-long program since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Easout, Cyprex, Lannate, and Ambush.

In our recommendations we suggest that such compounds be used in combination with other pesticides or that they be alternated with other pesticides so that the likelihood of resistance development is reduced.

It should be noted that several pesticides may act similarly. Thus, Benlate and Easout act on the same site and if resistance develops to one, it is likely to apply also to the other. This is called cross-resistance. Thus, alternating these compounds will not be useful. Rather, they should be alternated with fungicides with different modes of action, as for example, captan or maneb.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

i) correctly calibrating and maintaining spray equipment
ii) correctly operating the equipment
iii) being aware of the toxicity of the pesticide in use
iv) being aware of the weather conditions.

For more information consult OMAF Factsheet *Pesticide Drift*, Agdex 607 or Canadex 607 *Pesticides: Effects of Drift and Droplet Size*.

AERIAL APPLICATION

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act 1973 for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

FERTILITY AND SOIL MANAGEMENT

Soil Sampling and Testing
The addition of fertilizer to nursery stock and landscape plants should be based on the plants' nutrient requirements. Chemical soil tests are a way of evaluating the availability of soil nutrients and thus establishing the need for and amount of fertilizer to be added to attain optimum growth. Soil samples are easily taken and should be a continuing part of a grower's cultural program.

Samples are best taken to a depth of 20 cm, using a soil probe or spade from a minimum of 20 locations per hectare. Mix the soil thoroughly in a clean container and select a cupful for analysis. If the area to be tested is known to be of uniform soil type and has not received varying levels of fertilizer or organic matter, samples from the 20 locations may be bulked together. Samples from sandy and loamy soil should be kept separate, as should those from areas of poor drainage or manure addition.

From containerized stock, samples should be taken with a small-diameter sampling probe from at least 5 pots. Always sample prior to adding a dry surface fertilizer (granular or pellet) and avoid sampling immediately after liquid feeding. If water soluble fertilizer is being applied continuously, samples may be taken at any time. Where a dry fertilizer residue remains on part of the surface of the container mix, insert the probe so as to avoid the residue. The best way to obtain a sample is to remove the pot and take a core through the medium midway between top and bottom.

Soil samples from the field and from container, potting mixes are analyzed under contract for the Ministry of Agriculture and Food by Agri-Food Laboratories, 503 Imperial Road, Guelph, Ontario. Soil-sample boxes and field-information sheets are available from agricultural representatives, horticultural specialists and OMAF offices.

AVERAGE FOLIAR NUTRIENT CONTENT OF HEALTHY NURSERY STOCK

	N %	P %	K %	Ca %	Mg %	Mn ppm	Cu ppm	Zn ppm	B ppm	Fe ppm
Field grown										
broadleaf evergreens	2.3	.27	1.1	2.5	.3	25	5	27	42	120
conifers	1.7	.24	1.0	1.0	.2	88	6	31	35	87
deciduous trees & shrubs	2.8	.25	1.7	2.4	.4	62	7	25	58	133
Container grown										
conifers & broadleaf evergreens	2.5	.4	1.4	2.0	.3	52	5	24	48	127

Tissue Testing — Foliar Analysis

At the present time foliar analysis is used to diagnose suspected nutrient disorders to field-grown and container-grown nursery stock. Samples should be taken in July or August. From deciduous trees and broadleaf evergreen shrubs select approximately 50 fully expanded leaves midway along a shoot of the current season. From conifers select 10-15 ten cm long shoots of current season growth, removing the needles and discarding the twigs of pines, spruces and firs. If foliage is dirty it should be rinsed in clean water.

Samples should be air-dried or shipped in such a way as to avoid molding. General laboratories including Agri-Food Laboratories, Guelph, and the Department of Land Resource Science, University of Guelph, offer a foliar analysis service. The cost may vary among labs, but will be less than $20 per sample for 10 nutrient elements.

The table listed above will serve as a guide to normal foliar nutrient concentrations of nursery stock. Values for established landscape stock are usually somewhat lower.

Adjusting Soil pH

Soil pH is a measure of acidity or alkalinity on a scale from 0 to 14. The middle of the scale (7) is neutral, with values below 7 being increasingly acid and values above 7 increasingly alkaline. Most Ontario soils are between 5.0 and 8.5 As soil acidity increases the solubility of elements such as iron and manganese increases, while many other elements are less available below pH 5.0

Most nursery stock grows well between pH 5.0 and 7.2. Plants such as red maple, pine oak, tuliptree and enonymus may exhibit iron and/or manganese chlorosis if the pH is above 7.0. For ericaceous plants and conifer seedbeds, the pH should be below 6.5.

Lime is used to raise pH and would be useful where soil pH is low. General lime applications for most crops are listed below, assuming a 6.0 growing pH.

Sulfur can be used to lower pH. Other acidifying materials such as aluminum sulfate or iron sulfate are less effective than sulfur and are potentially phytotoxic, and their use is often limited to pot culture. The use of sulfur is not practical for large areas, thus the table below is based on rates of application per 100 square metres. In order to keep the pH at or near a desired level, the use of sulfur must be continued each year or every other year. A soil test for pH taken in the spring should be the basis upon which to continue the use of sulfur. It is not feasible to acidify soils with sulfur when the pH is above 7. If the pH must be lowered on small areas the soil should be replaced or amended with large quantities of acid peat. When using organic materials be sure to test the pH since leaf mold, compost and some peat may be basic rather than acidic.

RAISING SOIL pH TO 6.0 WITH LIME

Soil pH	Soil Texture		
	Fine (clays, clay loams)	Medium (loams, silt loams)	Course (sands, loamy sands, sandy loams)
	Lime Required — tonnes/hectare*		
4.5	11	9	7
4.5-5.0	9	7	5
5.1-5.5	7	5	3
5.6-6.0	5	3	2
6.0	0	0	0

* ton/acre = .45 x tonnes/hectare

Fertilizer materials such as ammonium sulfate and ammonium phosphate will cause a gradual reduction of soil pH when used from year to year. Ammonium nitrate and urea have only a slightly acidifying affect in the long run. Urea and anhydrous ammonia cause temporary but marked increases in pH when first applied. Superphosphate, potassium sulfate and muriate of potash have no affect on pH. Excess use of nitrogen fertilizers may, in time, require the addition of lime.

SOIL ACIDIFICATION TO pH 5.0 WITH SULFUR

	Soil Type			
Initial pH	Sand	Sandy loam	Loam	Clay loam
7.0	9*	11	14	17
6.5	8	9	11	14
6.0	6	7	8	11
5.5	3	4	5	8

* kg of elemental sulfur per 100 m^2 for 2 successive years

Nursery Stock Fertilization

Fertilization is an important part of producing nursery stock. Without the addition of fertilizer, optimum growth cannot be achieved and maximum profit per time per unit of land will not be realized.

Because nitrogen levels in the soil fluctuate rather quickly there is no adequate chemical test for nitrogen. Thus recommendations are not based on soil-test values. Use the phosphorus/potassium table as a guide for requirements of phosphorus and potassium. These values relate only to samples tested by Agri-Food Laboratories, Guelph.

Seed Beds, Transplant Beds

These are used for seedlings, rooted cuttings or grafts with the plants remaining usually for 2 years. The incorporation of organic matter, such as rotted barnyard manure or compost, is useful at a rate of approximately 45 tonnes per hectare prior to planting. Green manures grown on the land are a good source of organic matter also.

Adding fresh, undecomposed organic matter that is low in nitrogen will require the incorporation of nitrogen to compensate for microbial decomposition. If fresh sawdust is to be used apply 15 kg per tonne of actual nitrogen and incorporate.

When preparing the area incorporate phosphorus and potassium as indicated by soil test (see phosphorus/potassium table on page 12). Prior to planting in the spring incorporate approximately 50 kg of actual nitrogen per hectare if manure is not used. If manure is used additional nitrogen may not be required the first season, but may be used if based on the grower's previous experience with the crop. In early spring of the second season apply phosphorus and potassium as indicated by soil test and nitrogen at the rate of 50-75 kilograms per hectare. Individual growers may wish to increase nitrogen applications based on trials for particular species under their growing conditions.

Established Field Stock

Here again fertilizer application should be based on soil-test recommendations. The table on page 12 may be used for phosphorus and potassium. Nitrogen, for which no good test is available, is utilized quickly and is easily lost by leaching. Nitrogen applications of 100 kg of actual nitrogen per hectare per season are recommended. Individual growers may wish to increase nitrogen applications based on trials for particular species under their growing conditions. More nitrogen and potassium fertilizer will be required to maintain optimum levels of fertility in sandy soil than in clay. When no soil test is available, applications of a 3-1-2 ratio fertilizer at the rate of 100 kg actual nitrogen per hectare are suggested.

Fertilizer may be applied in the spring 2 to 4 weeks prior to the resumption of growth and in the fall after top growth has ceased (mid-September to mid-October). So long as soil temperatures remain above 5°C, roots will continue to grow and absorb nutrients. Research indicates that growth, the season after fall fertilization, is significantly better than after fertilization during the spring of the same season. Apply no more than 1/2 to 2/3 of the total fertilizer required for the season in the fall.

Do not apply fertilizer in late fall or winter, because much of it will be lost through runoff and will not be absorbed because of the cold soil temperatures. Little nitrogen should be applied between approximately mid-July and early September to avoid the possibility of stimulating succulent growth in the fall, unless nitrogen is being applied in small amounts regularly throughout the growing season, or it is a slow release formulation.

PHOSPHORUS (0.5 N Sodium Bicarbonate)			POTASSIUM (1 Normal Ammonium Nitrate)	
Soil Test Value ppm	Phosphate (P_2O_5) Required kg/ha New Planting Established		Soil Test Value ppm	Potash (K_2O) Required - kg/ha New or Established
0-3	140L	100L	0-15	130L
4-5	130L	90L	16-30	120L
6-7	120L	80L	31-45	110L
8-9	110L	70L	46-60	100L
10-12	100L	70L	61-80	90L
13-15	90L	60L	81-100	80L
16-20	70M	50M	101-120	70M
21-25	60M	40M	121-150	60M
26-30	50M	30M	151-180	40M
31-40	40M	20M	181-210	0H
41-50	0H	0H	211-250	0VH
51-60	0VH	0VH	250 +	0E
61-80	0E	0E		
80 +	0E	0E		

L — low; M — medium; H — high; VH — very high; E — excessive

Nursery Container Culture

Pots Those for container growing are most commonly constructed of high density plastic. Pots molded from recycled tires are also available. Plastic bag pots, although not commonly used, are inexpensive, easy to store, easily disposable and are worth considering. Fiber pots are not recommended for long-term growing because they begin to soften and decompose. Rough handling, although never advocated, may damage the fiber pots. Fiber pots are very useful for short-term growing and field potting prior to overwinter storage or spring shipping. All currently distributed potting machines will accept plastic and fiber pots. Special clips are usually necessary for plastic bag pots.

Pot color will affect the temperature of the mix and thus the roots. Several studies have shown that black and dark green pots are as much as 10° hotter than white or light reflective pots, reaching at maximum nearly 50° on the inner surface of the sunny side. When media temperatures approach 30° root growth decreases. Pots with a white or reflective exterior are not widely available. They would be useful along the outside rows of a block or for widely spaced plants. In the center of a pot-to-pot block, sunlight will not strike the pot wall. To diagnose high temperature injury remove the pot and compare root growth on the sunny and shaded sides of the pot.

Root circling is a potential problem in circular pots although not for most of the stock currently grown in Ontario for landscaping purposes. Square pots or vertical ribs will help to reduce root circling and increase root branching. However, very few large pots of such design are available.

Mixes Potting mixes are a very critical component in a successful container-growing operation. The importance of adequate aeration cannot be overemphasized. Water holding ability is also important but is a secondary factor compared to aeration. Roots require adequate air (oxygen) to grow properly. A poorly aerated mix will restrict root growth of plants because of insufficient oxygen.

Total porosity of a mix is the amount of spaces between particles that could potentially be filled with either air or water. A value above 50% is adequate for total porosity. More important than total porosity is aeration porosity. This is the amount of space in the mix filled with air after irrigation water has drained out.

If aeration porosity is as low as 10 the mix is poorly drained while values above 25 are considered too high. Too much aeration is not bad, it only means that frequent irrigation will be necessary.

Mix ingredients should be free of insect, disease and weed pests; they should be readily available to assure a continuous supply and should not be overly expensive. Also the mix should not be so lightweight that pots of tall plants blow over in the wind.

Peat has been the traditional mix ingredient mixed with equal parts of concrete grade sand. However, such a mix becomes alkaline when a high pH sand is used and aeration is somewhat low.

Bark is becoming more common as a mix ingredient. It provides good aeration when combined with equal parts of peat. Mixes such as 1 part each of bark, peat, sand or 2 parts bark and peat and 1 part sand provide adequate aeration and water holding capacity. Another advantage of bark is that it helps to control root rot disease organisms. Coarse sawdust that is well decomposed is also useful as a mix ingredient. Fresh sawdust should be avoided because of its very high C/N ratio. The C/N ratio of sawdust is 1000/1, of conifer bark 300/1 and of hardwood bark 150/1.

Bark should be hammermilled through a 12-15 mm screen so that 60% of the particles are between .5 and 5 mm in diameter. Before making the potting mix, it is good to compost for 2 months by stockpiling and turning occasionally. To compensate for the high C/N ratio and to enhance decomposition add approximately 1 kg of N (e.g. ammonium nitrate) per cubic metre of bark. Hardwood bark will decompose more quickly than conifer bark.

pH Media pH should be between 5.5 and 7.0. Although *Juniperus* and *Thuja* will grow adequately at a higher pH, plants such as *Euonymus, Rhododendron* and *Taxus* will exhibit iron and/or manganese chlorosis if the pH is above 7.0. With pH sensitive crops do not use alkaline sand in the mix. Irrigation water can be acidified with phosphoric acid. Also, acidifying fertilizers may help to control pH. For those using injectors, store fertilizer and acid concentrates as separate solutions.

Fertilizers The addition of fertilizers is a necessity for any container mix. Most mixes contain little if any soil, so inherent fertility would be very low. Several alternatives are available.

Liquid feeding with totally water-soluble fertilizers is widely used and is an accurate way to apply fertilizer. This type of fertility program requires an accurate concentrate diluter in the irrigation system. In theory, soluble fertilizers should be applied at every watering, but results seem to indicate little difference in growth between constant and intermittent fertilizing.

Commercial water-soluble fertilizers are available in numerous analyses. One — such as a 20-20-20 formulation including minor elements is a useful all-purpose fertilizer. Use at the rate of 200 ppm nitrogen (100 g of 20-20-20 per 100 L of water) for constant feeding. Increase the rate to 400 ppm for infrequent intermittent fertilizing.

If water-soluble fertilizers do not contain minor elements they should be added to the mix prior to potting or as soluble trace elements during the growing season. Dry materials with added bulking agents are less concentrated and thus easier to blend into the mix. Use them as recommended by the manufacturer.

There are several slow-release fertilizers available for containerized production of nursery stock. These materials are incorporated when making the potting mix. Use at the manufacturer's suggested rates. When preparing the mix, avoid excessive mixing which may break down the particles and result in fertilizer toxicity. If these potting mixes are to be stored outdoors for an extended time, the pile should be covered to prevent leaching.

Using slow-release materials, which usually contain no micronutrients, will necessitate the addition of trace elements (manufacturer's recommendation). Dolomitic limestone (2 kg or less per cubic metre) will be needed when mix ingredients are low in calcium and magnesium. Superphosphate is often recommended by the manufacturer of some slow-release fertilizers, because of inadequate phosphorous release.

Research trials indicate that supplemental fertility, particularly nitrogen, may be beneficial for some crops grown with pre-incorporated fertilizers. Apply nitrogen at the rate of 200 ppm if nitrogen readings from soil tests are low. During the second growing season following the use of pre-incorporated slow-release materials, nutrients may be supplied by water-soluble fertilizers in the irrigation system or surface-applied fertilizers. Research has shown that *Juniperus*, in mixes with low aeration porosity, grew better the first year with a pre-incorporated fertilizer. When the plant is small and growing in a 6 L pot the need to water in order to fertilize may result in poor growth due to low aeration.

Soil tests are an important part of a container production operation. Potting mixes do not retain nutrients and the quantity of water applied causes rapid leaching. Biweekly sampling is suggested. Once the grower becomes familiar with test results, pH and salt readings may be sufficient information at each sample time. Nutrient analysis can be less frequent. When using water-soluble fertilizers salts are normally lower than when using pre-incorporated slow release, both at the recommended rates.

Fertility control of container-grown plants in the garden center is important to ensure proper growth, particularly if the plants have been grown previously under a liquid fertilizer program. Add a slow-release fertilizer at manufacturer's recommendation. Do not add fertilizer on the surface prior to shipping.

Fertilizing Landscape Plantings

Fertilization is a cultural practice which should be carried out as warranted by the soil characteristics, the type of plant and the growth desired. Most of our natural soils have enough inherent fertility to allow plants to grow. An application of fertilizer may be needed to aid establishment after transplanting or to maintain vigor. If landscape plants are growing well there is no need to fertilize them. At planting only superphosphate (1.5 kg per cubic metre of backfill) is recommended.

Any complete fertilizer which is high in nitrogen and potassium but low in phosphorus is fine for trees and shrubs. Although phosphorus is an important nutrient, particularly for root growth in newly planted trees, it does not leach readily as do nitrogen and potassium. The two best times to fertilize are: early spring before growth begins and fall after the danger of growth stimulation. Avoid using a quick release fertilizer between mid-July and early September.

The required amount of fertilizer should be evenly distributed on the soil surface beginning well beyond the branch spread and extending inward to two-thirds the distance between the dripline and the trunk. If part of the area under the branch spread is obstructed by paving, reduce the quantity of fertilizer applied accordingly. Trees growing in lawn areas benefit from fertilizer applications to the grass. Apply a turf grade fertilizer to the areas at the rate higher than that recommended for the grass. Applications in early spring will help avoid stimulating the grass. Pressure injection of slow release fertilizer into the soil is acceptable. The drill hole method of tree fertilization is not generally recommended unless the soil is in need of aeration.

Micro-nutrients such as iron and manganese may be applied as foliar sprays to correct chlorosis, although several sprays during a season may be required, or capsules may be implanted into the trunk. Follow manufacturer's recommendations. Applying macro-nutrients such as nitrogen, phosphorus and potassium as foliar sprays is generally not practical.

There are causes of yellowing of leaves other than nutrient deficiencies, and fertilizers will not correct these. In fact, improper fertilizer application to stressed trees may do more harm than good.

RECOMMENDED RATES OF FERTILIZER FOR TREES

Trunk diameter	Rate per cm diameter
less than 15 cm	0.2-0.4 kg
more than 15 cm	0.4-1.0 kg

Measure trunk diameter at 1.0 or 1.5 m above the ground.

Rates are based on a complete fertilizer containing 10% nitrogen.

Use the minimum figures for evergreen and deciduous trees in areas where the growing season is limited (Plant Hardiness Zones 1-4). In warmer parts of Ontario the higher rates may be used.

Water thoroughly after fertilizing.

Method to Determine Mix Porosity

You will need: (1) your normal pot; (2) a way to cover or plug the pot drain holes; (3) a graduated cylinder or other liquid measure; and (4) some dry mix. Use this method to test new mixes. Plant growth in your standard mix and a new one, each with its respective aeration value, will be your guide to the best mix. Select mixes with high aeration porosity (in the range of 20-25) for items such as pine and yew. Somewhat lower values can be tolerated by junipers and white cedar.

- With the drain holes covered or plugged fill the container with water to the normal potting level. This amount of water is total container volume (=A).
- Empty the water and fill the pot with a nearly dry mix. Add water very slowly until a slick of water appears on the surface. Be sure the pot is level. Do not rush. The water added is (=B).
- Without moving the pot remove the drain hole covers or plugs allowing the water to drain into a bucket. Measure the water drained (=C).

$$\text{Total porosity} = \frac{B}{A} \times 100$$

$$\text{Aeration porosity} = \frac{C}{A} \times 100$$

- To determine the water retention porosity which is similar to the moisture at field capacity of a soil, subtract aeration porosity from total porosity.
- Example

pot volume = 5180 mL (=A)
water added to saturate mix = 3354 mL (=B)
water drained when holes uncovered = 1080 mL (=C)

Total porosity = 65%

$$\frac{3354}{5180} \times 100 = 65\%$$

Aeration porosity = 21%

$$\frac{1080}{5180} \times 100 = 21\%$$

Water retention porosity = 44%
65 — 21 = 44%

RECOMMENDED RATE OF FERTILIZER FOR HEDGES

Plant size	Rate per 30 linear metres
small (under 1 m)	0.5 kg
medium (1.0-2.5 m)	1.0 kg
large (over 2.5 m)	1.5

Rates are based on a complete fertilizer containing 10% nitrogen.
Water thoroughly after fertilizing.

This table contains recommendations for adjusting a feeding program based on media nutrient levels obtained from soil test reports issued from the Agri-Food Laboratories, Guelph. The nutrients are reported as the amount available in parts per million (ppm) and the recommendations are based on a normal feeding program. Soil test results may be inconsistent when encapsulated fertilizers are used in the feeding program due to the breaking of the capsules during sampling, shipping or testing.

Current soil tests measure only nitrate nitrogen. Thus, any ammonium in the mix is not detected. Woody plants utilize both nitrate and ammonium forms, with nitrate being more important except for such plants as oak, ericaceous plants, and conifer seedlings.

SOIL NUTRIENT LEVELS FOR MOST CONTAINER CROPS

NITROGEN — as water-soluble Nitrate (No_3) N	
Low 0-15 ppm	Add additional nitrogen to feeding program, if using slow release materials.
Normal 20-55 ppm	Continue feeding program at high levels, check total salts.
Excess above 60 ppm with high salts	Discontinue feeding, check total salts. Root damage may occur. Higher rates of fertilizer may be required to give optimum growth in a bark mix and also to maintain the same soil test level as in a peat mix.
PHOSPHORUS — as water-soluble P	
Low 0-10 ppm	Add additional phosphorus to feeding program.
Normal 11-50 ppm	Continue feeding program at high levels, check total salts.
Excess above 50 ppm	Discontinue feeding phosphorus.
POTASSIUM — as water-soluble K	
Low 0-15 ppm	Add additional potassium to feeding program.
Normal 20-60 ppm	Continue feeding program. At high levels check total salts.
Excess above 60 ppm	Discontinue feeding and leach (leaching is not effective for incorporated slow-release fertilizer). Somewhat higher levels may be tolerated if the mix contains a high proportion of organic material.
TOTAL SALTS — mhos X 10^{-5}	
Low 0-29 ppm	Check for adequate nitrogen and potassium levels.
Normal 30-120 ppm	Continue feeding program.
Excess above 130 ppm	Discontinue feeding. Higher levels may be tolerated if the mix contains a high proportion of organic material.

MISCELLANEOUS

Calcium should be 150 or above. Sulfates should be below 300; magnesium above 5. Chlorides should be below 50 and pH between 5.0 and 7.0.

RECOMMENDED RATES OF FERTILIZER FOR SHRUBS

Type of shrub	Rate: Grouped in beds	Rate: Large specimens
Deciduous	0.5-1.0 kg per 10 m^2	0.25-0.50 kg per plant
Broadleaf evergreen	0.5-1.0 kg per 10 m^2	0.25 kg per plant
Narrowleaf evergreen	0.5-1.0 kg per 10 m^2	0.25-0.50 kg per plant

Rates are based on a complete fertilizer containing 10% nitrogen.

Use the low figures in areas where the growing season is limited (Plant Hardiness Zones 1-4). In warmer parts of Ontario the high rates may be used.

Water thoroughly after fertilizing.

Fertilizing Turf

The application of phosphorus and potassium to turf areas should be based on a soil test such as that provided by Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario N1H 6T9. The Lab will provide the necessary sample boxes and information sheets. Due to the relatively shallow rooting of turf, soil samples should be taken to a depth of 15 cm except on special turf such as greens and tees where a 7.5 cm depth is preferable. Information sheets should accompany all samples and should characterize all samples as being from a) greens and tees; b) fairways and playing fields; c) parks, cemeteries and low-use turf; and d) nursery sod. For those samples analyzed by the Agri-Food Laboratories the table on page 16 may be used to determine the rate of application of phosphorus and potassium.

Phosphorus is very important at the establishment of turf grasses. The phosphorus recommendations for greens and tees should be used for all types of turf at the establishment stage. As a general recommendation where a soil test is not available, 3 kg P_2O_5/100m^2 should be applied and worked into the surface prior to final seedbed preparation

The color, density and vigor of turf is primarily dependent on the amount of nitrogen fertilizer used. The amount of nitrogen to apply may be obtained from guidelines printed on page 16 and adjusted according to the desire of the turf manager for increasing or decreasing the frequency of application as needed. Nitrogen may be obtained from a complete fertilizer such as a 1-1-2 ratio or by using ammonium nitrate, urea or slow-release nitrogen materials. Where water soluble ammonium nitrate or urea are used they should be watered-in to avoid foliar burn. It is preferable to use a fertilizer spreader, travelling in two directions at half rate to obtain a uniform application of nitrogen and hence uniform color in turf.

Maintaining green color in late fall, followed by early spring growth without excessive succulence may be obtained by using a "winterizer" fertilizer. The material recommended is a high nitrogen-low potassium fertilizer, applied at 1 to 1.5 kg N/100 m^2 between Oct. 20 and Nov. 5. Applications of nitrogen the following spring should be delayed until June 1 or later.

There is no evidence of a need for trace elements for the production of turf in Southern Ontario. Turf species produce satisfactorily down to a pH of 5 hence liming is seldom required.

PHOSPHORUS AND POTASSIUM REQUIREMENTS FOR TURF AND NURSERY SOD

Soil Phosphorus (0.5 N sodium bicarbonate)	Greens, tees, lawns & fairways	Low use turf	Nursery sod	Soil Potassium (1 N amm. acetate)	Greens & tees	Lawns & fairways	Low use turf	Nursery sod
ppm P in soil	phosphate (P_2O_5) required — kg/ha			ppm K	Potash (K_2O) required — kg/ha*			
0-3	370 L	90 L	230 L	0-15	400 L	200 L	90 L	140 L
4-5	360 L	80 L	210 L	16-30	360 L	180 L	80 L	120 L
6-7	350 L	70 L	200 L	31-45	320 L	160 L	70 L	80 L
8-9	340 L	60 L	190 L	46-60	280 L	140 L	50 L	60 L
10-12	320 L	40 M	170 L	61-80	200 L	100 L	30 M	50 M
13-15	300 L	30 M	150 M	81-100	160 L	80 M	20 M	40 M
16-20	260 L	20 M	130 M	101-120	120 M	60 M	20 M	30 M
21-25	220 M	0 H	110 M	121-150	80 M	40 M	0 MH	30 M
26-30	170 M	0 H	90 M	151-180	40 M	40 M	0 VH	0 H
31-30	120 M	0 VH	70 H	181-210	0 H	0 H	0 VH	0 VH
41-50	70 H	0 VH	50 H	211-250	0 VH	0 VH	0 VH	0 VH
51-60	40 H	0 VH	40 H	250 +	0 E	0 E	0 E	0 E
61-80	0 VH	0 E	30 H					
80 +	0 E	0 E	0 E					

*Above rates are total yearly applications. Not more than 90 kg/ha should be applied in any one application except for nursery sod which may receive the total yearly amount in one application before seeding.

*Approved by the Ontario Soil Management Research Committee. Effective Sept. 1, 1984.

NITROGEN REQUIREMENTS FOR TURF AND NURSERY SOD*

Greens & tees	—Not more than 400 kg N/ha in 6-8 applications of not more than 50 kg N/ha per application.
Lawns & fairways	—Not more than 200 kg N/ha in 4 applications if clippings are left on fairways with not more than 30 kg N/ha per application.
Low use turf	—50 kg N/ha applied once per season.
Nursery sod	—Prior to the final cultivation before seed bed preparation, apply 90 kg N/ha where the soil is a coarse texture. Where the soil is a medium or fine texture, is high in organic matter, or has a history of luxuriant growth, reduce the initial application to 50 kg N/ha. As early as feasible the following spring apply 70 kg N/ha on turf where there is less than 85% groundcover. Reduce the rate to 35 kg N/ha where vigorous growth is evident. In mid or late June apply 50 kg N/ha. Withhold further applications until three weeks prior to harvesting at which time apply 35 kg N/ha. Where sod is held over to the following year apply 45 kg N/ha in September, April, and every 10 weeks until harvest.

*Approved by the Ontario Soil Management Research Committee Effective Sept. 1, 1984.

INSECTS AND MITES AFFECTING TREES AND SHRUBS

All plants are subject to attack by one or more species of insect or mite. The potential for injury exists throughout the growing season from the first warm days of spring until the freezing weather of autumn. Fortunately, most of the time natural control factors keep pest populations at a level where plants are not damaged. However, conditions favorable for the multiplication of one pest or another occur from time to time and artificial control measures must be applied if serious injury is to be prevented.

In order that these measures may be as effective, safe and economical as possible it is necessary to detect changes in pest numbers and activity at an early stage of development. This is accomplished by frequent inspection of the plants. In addition, it is necessary to be able to identify the pest concerned, and know how and when best to deal with it.

The following information has been compiled to help meet these objectives.

DESCRIPTION OF PESTS AND DAMAGE CAUSED

Insect and mite pests may best be considered according to the manner in which they feed and the damage they cause. The following broad groupings have been selected: defoliators, sucking insects, borers, and gall makers. Often the damage is so characteristic that the causal agent may be identified without actually seeing the pest at work. Indeed some pests, particularly mites, are so small that they cannot readily be seen by the unaided eye. Other pests develop within the tissues of the plant and are thus concealed.

DEFOLIATORS

This group of insects eats solid foliage tissue. Their habits are quite diverse: they may consume entire leaves or only the interveinal tissue; skeletonize only one surface or mine between the leaf surfaces; feed singly or in dense colonies; develop exposed or within the protection of a web, folded leaf, or portable shelter. Reduction of leaf area through defoliation stops, or interferes with the elaboration of food materials by the photosynthetic process, with transpiration, and with the translocation of food

within the tree. Some of the more common defoliators are listed below.

LEAF-CHEWING CATERPILLARS (the immature stage of moths or butterflies)

Fall cankerworm, *Alsophila pometaria*, and the **Spring cankerworm**, *Paleacrita vernata*, occur in mixed infestations early in the season. They are greenish-to-black loopers and attack the foliage of a wide range of deciduous hosts.

Eastern tent caterpillar, *Malacosoma americanum*, forms the familiar silken tent in the forks of branches mainly of apple, cherry and hawthorn trees. The **Forest tent caterpillar**, *Malacosoma disstria*, does not form a tent but may completely defoliate broadleaved trees, particularly poplars, over a wide area. Both species are present early in the season, and the larvae feed in colonies.

Fall webworm, *Hyphantria cunea*, forms a large web in late summer over the ends of branches of ash, box-elder, flowering crab and many shade trees. The caterpillar is pale yellowish-green and very hairy.

Birch skeletonizer, *Bucculatrix canadensisella*, is a small, yellowish-green larva which feeds on the undersurface of the leaves from mid- to late summer. Only birches and possibly alders are attacked.

Greenstriped mapleworm, *Dryocampa rubicunda rubicunda*, has a cherry-red head and yellowish body with seven dark lines running its entire length. Its preferred hosts are maple, oak and box-elder.

Gypsy moth, *Lymantria dispar*, caterpillars are dark and hairy with 5 pairs of blue tubercles or spots followed by 6 pairs of red tubercles along their backs. Caterpillars feed in the spring and early summer, reaching about 6 cm in length when mature. They consume the foliage of a wide range of trees and shrubs, but prefer basswood, birch, hawthorn, oak, poplar and willow.

Hemlock looper, *Lambdina fiscelleria fiscellaria*, is a grayish caterpillar flecked with black dots, about 30 mm long. It prefers hemlock, balsam fir and white spruce, but will feed on several other coniferous and broadleaved hosts.

Juniper looper, *Thera juniperata*, is a greenish caterpillar with a whitish and reddish line along each side. It feeds on juniper during September.

Juniper webworm, *Dichomeris marginella*, is a light brown caterpillar 12 mm long. It feeds at the base of the needles and webs them together during early fall and again the following spring.

Leafroller is a caterpillar that feeds in concealment it provides for itself by folding or rolling leaves together. **Fruittree leafroller**, *Archips argyrospilus*, and **Redbanded leafroller**, *Argyrotaenia velutinana*, are primarily pests of fruit trees but also attack a wide range of shade trees and ornamentals.

Linden looper, *Erannis tiliaria*, is bright yellow with a rusty brown head and 10 wavy black lines down the back. It is present from early spring until July and attacks a wide variety of hardwoods.

Maple trumpet skeletonizer, *Epinotia aceriella*, spins a long trumpet-like tube of silk and frass on the underside of a leaf causing the leaf to fold around it. It feeds from within this tube and skeletonizes the part of the leaf covered by the web, causing it to crumple. It may also attack hawthorn and beech.

Oak leaftier, *Croesia semipurpurana*, is a small, whitish larva which enters unopened buds in May and feeds on the young leaves, later tying the leaves together and shredding the tissue. It attacks only oaks.

Oak skeletonizer, *Bucculatrix ainsliella*, is a small yellowish-green larva which feeds on the lower surface of oak leaves. There is one generation in June and a second in August and September.

Orangestriped oakworm, *Anisota senatoria*, is black with orange or yellow stripes running lengthwise down the sides and back. Two stiff black horns project from the top of the second body segment, and there are small sharp spines on the other body segments.

Pine webworm, *Tetralopha robustella*, is yellowish-brown with two dark longitudinal stripes on each side. Colonies of the larvae feed on needles enclosed within masses of coarse webbed frass on twigs and branches during midsummer.

Spiny elm caterpillar, *Nymphalis antiopa*, is also commonly known as the mourning cloak butterfly in the adult stage. The larva is black with scattered white dots, and the body is covered with many large, branched spines. They feed gregariously on elm, willow and poplar.

Spruce budworm, *Choristoneura fumiferana*, has a black head and brownish body with four light spots on the back of each segment. It is a widespread and important defoliator of balsam fir and spruce.

Walnut caterpillar, *Datana integerrima*, is black with gray hairs, and is the most important leaf eater of walnut. The caterpillars descend as a colony to molt and thus leave a conspicuous clump of gray cast skins on the trunk.

LEAF-EATING BEETLES

Elm flea beetle, *Altica ulmi*, is a small, metallic-blue beetle that eats holes through elm leaves soon after they unfold in the spring. The larvae are small, blackish grubs that skeletonize the underside of the leaves.

Elm leaf beetle, *Pyrrhalta luteola*, is olive-green with a dark stripe on each wing cover. The beetles chew holes in the leaves and the larvae skeletonize the underside. All species of elm may be attacked.

Imported willow leaf beetle, *Plagiodera versicolora*, is a small, oval, metallic-blue beetle. Both the adults and the larvae skeletonize the leaves of willow and Lombardy poplar. There are two or more generations a year.

Rose chafer, *Macrodactylus subspinosus*, is a longlegged, tan-colored beetle, densely covered with short, dull-yellow hairs. They appear in swarms in early June and feed on the opening buds of a wide variety of hosts. Later they attack the flowers, fruit and foliage. The larvae feed mostly on the roots of grasses but may also attack the roots of tree seedlings.

SAWFLIES

The adults of sawflies are four-winged insects often resembling small, amber-colored bees. The larvae of most species are caterpillar-like with more than five pairs of prolegs. They feed in colonies and strip the foliage from the host plants in a short time. Some common species are **Larch sawfly**, *Pristiphora erichsonii*, **Mountain ash sawfly**, *Pristiphora geniculata*, and **Privet sawfly**, *Macrophya punctumalbum*.

Several species of sawflies attack pines. The **European pine sawfly**, *Neodiprion sertifer*, has a dark-greenish body and black head, and is present from late May through June.

Redheaded pine sawfly, *Neodiprion lecontei*, has a yellow body with six rows of black spots, and a reddish head. It is present during July and August.

Larvae of the **Pearslug**, *Caliroa cerasi*, and **Roseslug**, *Endelomyia aethiops*, resemble small naked snails. Their tadpole-shaped bodies are covered with a slimy, olive-green material secreted by them. They skeletonize the leaves, making them appear scorched and causing them to drop prematurely.

LEAFMINERS AND CASEBEARERS

Larvae of insects in these groups are concealed during the greater part of their development within the tissues of the leaves or within a protective case made of leaf fragments which they carry to the feeding site. The tunnels of leafminers may be straight, serpentine or blotch, and are sufficiently characteristic to permit identification of most species.

Arborvitae leafminers constitute a complex of four species of caterpillars of which *Argyresthia thuiella* is the most common. Feeding causes the branch tips to turn brown. Adult is a small light grey moth that appears in late June and early July.

Bagworm, *Thyridopteryx ephemeraeformis*, is readily recognized by its curious spindle-shaped feeding case of loosely constructed leaf fragments. It attacks a wide range of coniferous and deciduous trees.

Birch leafminer, *Fenusa pusilla*, forms a blotch mine involving half or more of each leaf. Foliage of heavily infested trees appears to have been scorched. There are at least two generations a year. Adult is a small black fly that appears when the first birch leaves are half grown.

Lilac leafminer, *Caloptilia syringella*, causes blotch mines and later rolls or webs several leaves together to form a feeding shelter. Lilac, black ash, privet and euonymus may be attacked.

Locust leafminer, *Odontota dorsalis*, damages primarily the foliage of black locust in both the adult and larval stages. Heavy infestations render trees very unsightly. There may be two generations a year.

Spruce needleminer, *Taniva albolineana*, bores into the bases of old needles. Young larvae feed gregariously, older larvae singly. Unsightly nests are constructed of dead needles and frass held together by fine strands of silk. Small grey moths may be observed throughout infested plants in late May and June.

SUCKING INSECTS

This group of pests weakens trees and shrubs by sucking out the sap, and frequently injecting secretions which injure or kill plant cells. Most species are small and inconspicuous; nevertheless, some are among the most troublesome pests. Because the foliage is not torn or broken, plants may become infested and severely injured before the pest is known to be present. Signs of damage are mottling and fading of leaf color, curling and twisting of leaves, wilting of foliage and tender shoots, hardening of flower buds and malformation of flowers. Sucking insects include aphids, lacebugs, leafhoppers, mealybugs, mites, scales, spittlebugs and thrips.

APHIDS

Aphids, or plant lice, are small, soft-bodied, pear-shaped insects that may vary from green to shades of red, brown or black. They may attack a plant both above and below the ground, but commonly cluster on new growth or on the underside of leaves. Aphids secrete a sweet, sticky substance called "honeydew". This attracts ants, flies and wasps, and is a nuisance when it coats objects beneath infested plants. A black, sooty mold may grow on the honeydew, making plants unsightly.

Some species, such as **Beech blight aphid**, *Fagiphagus imbricator*, **Pine bark aphid**, *Pineus strobi*, and **Woolly larch aphid**, *Adelges lariciatus*, have the body covered with conspicuous cottony threads.

Many aphids have very complex life histories, involving several generations a year, alternate host plants, winged and wingless forms which may lay eggs or give birth to living young.

Honeysuckle aphid, *Hyadaphis tataricae*, causes early-season curling and dwarfing of apical leaves of *Lonicera*, especially *L. tatarica rosea* and *L. korolkowil zabilii*. The affected portion of the branch may reach several centimetres in length. Eventually the affected stem will die resulting in the typical witches' broom malformation which may completely disfigure heavily affected bushes. Dead shoots are particularly evident in the spring following attack.

LACEBUGS

These flat, rectangular insects are about 4 to 6 mm long, and are dark with broad, transparent, lacelike wing covers. Both adults and nymphs feed on the underside of leaves. They extract so much plant juice that leaves become pale and mottled with white splotches. The lower surfaces of leaves are spotted with black and brownish dots. Heavily infested leaves may turn entirely brown and fall off. Most species have two generations a year. Lacebugs usually occur on a single host. Trees commonly attacked are ash, elm, hickory, linden, oak and walnut.

LEAFHOPPERS

Leafhoppers are small, wedge-shaped, active insects that run, hop, or fly when disturbed. They are usually greenish or yellow, although a few kinds are striped. Leafhoppers feed on the underside of leaves, causing them to become light in color and marked with small white dots on the upper surface. Often the cast skins of the nymphs remain attached to the lower surface of a leaf and their presence helps identify the cause of injury. Woody hosts most commonly injured by leafhoppers are apple, elm, honeylocust, maple and rose.

MITES

Mites are not insects, but tiny animals closely related to spiders and ticks. Sometimes called "spider mites", they produce webbing between the needles or leaves which protects them from dislodgement as well as from their natural enemies. Mite activity causes speckling, bleaching or bronzing of the foliage, and spotting with tiny spherical eggs or broken eggshells. In severe infestations the foliage may drop prematurely, killing the plant. Mites have high reproductive capacity and their numbers increase rapidly during hot dry weather. Since plants may therefore be seriously damaged in a short period of time, it is important to determine early in the season if mites are present on plants. Because most mites can barely be seen with the naked eye, hold a sheet of white paper under a branch, and tap it sharply. Some mites will drop onto the paper and can be seen as tiny specks as they crawl about. Evergreens and deciduous trees are both subject to mite attack, and there may be several generations a year.

Mite species commonly associated with trees are **Clover mite**, *Bryobia praetiosa*, on the honeysuckle and elm; **European red mite**, *Pananychus ulmi*, on apple, mountain ash and elm; **Honeylocust mite**, *Platytetranychus multidigituli*, on honeylocust and moraine locust; **Oak red mite**, *Oligonychus bicolor*, on oaks; **Pear Leaf Blister Mite**, *Eriophyes pyri*, on mountain ash; **Spruce spider mite**, *Oligonychus ununguis*, on spruce, hemlock arborvitae, and juniper; **Twospotted spider mite**, *Tetranychus urticae*, on elm, linden, rose, and ornamental fruit trees; and several species of **rust mite** on elm, honeylocust, maple, oak and privet.

NOTE Because mites are not insects, they are not effectively controlled by all insecticides. Therefore, it is often necessary to employ a material formulated specifically for control of mites. Some of the common miticides, or acaricides, are dicofol (Kelthane), Plictran, Morestan. These should be used according to the manufacturer's directions on the container label.

SCALES

Scale insects are inactive during most of their lives. They are quite small and often blend in color with the host plant, so they are hard to find. For ease in identifying, scales may be divided into three groups: armored scales, soft or unarmored scales, and mealybugs.

Armored scales are the most common type on trees and shrubs. They secrete a hard, waxy covering over their bodies and may be circular, oblong or pear-shaped. Armored scales vary from 2 to 3 mm in length or diameter.

Oystershell scale, *Lepidosaphes ulmi*, attacks over 100 species of forest, shade, fruit and ornamental trees, and is often particularly important on ash and lilac. In heavy infestations the greyish scales completely encrust the twigs and stems, and can cause branch and tree mortality.

Pine needle scale, *Chionaspis pinifoliae*, appears as whitish drops on the needles of pines and spruces.

Juniper scale, *Carulaspis carueli*, is a small white scale that turns the needles of juniper and arborvitae yellow.

Euonymus scale, *Unaspis euonymi*, is a greyish, pear-shaped scale infesting euonymus, bittersweet, and pachysandra. It produces two generations a year.

San Jose scale, *Quadraspidiotus perniciosus*, is a small, flat, circular scale with a dark central nipple. It infests a wide range of shade and fruit trees.

Soft scales are either bare or enclosed in waxy or cottony secretions.

Cottony maple scale, *Pulvinaria innumerabilis*, resembles a partially popped kernel of corn. It attacks maple, linden, elm, beech, oak, and other trees and shrubs.

Tuliptree scale, *Toumeyella liriodendri*, is a dark brown, hemispherical scale attacking several species of deciduous trees.

Pine tortoise scale, *Toumeyella numismaticum*, is a reddish-brown, oval, very convex scale about 6 mm long. It attacks several kinds of pine.

European fruit lecanium, *Lecanium corni*, is a large, reddish-brown, convex scale, usually on the underside of twigs. It infests a wide range of deciduous trees and shrubs.

Fletcher scale, *Lecanium fletcheri*, closely resembles the European fruit lecanium. It attacks yew, arborvitae and juniper.

Spruce bud scale, *Physokermes piceae*, is a globular, mahogany-brown scale that clusters at the nodes of spruces. Lower branches become ragged with some die-back.

Golden oak scale, *Asterolecanium variolosum*, feeds in small pits on the twigs, branches and trunks of white oaks.

Mealybugs are soft-bodied and usually covered with a powdery, cottony-wax material. They vary from about 5 to 8 mm in length when full grown. They produce honeydew, but unlike the other kinds of scale insects they can move about throughout their entire life cycle.

Taxus mealybug, *Pseudococcus cuspidatae*, is a slow-moving, white, "woolly" insect which may completely cover branches and trunks of heavily infested plants with a waxy secretion. Feeding discolors the needles and causes excessive needle cast. All species of yew are attacked.

Woolly maple scale, *Phenacoccus acericola*, produces white cottony masses on the underside of sugar maple leaves during the summer. There is more than one generation a year. Linden, ironwood and horsechestnut may also be attacked.

Other sucking insects of importance are **Pine spittlebug**, *Aphrophora cimbrata* which forms masses of spittle on the branches and trunks of pines; and **Thrips** which are tiny, slender-bodied insects affecting the leaves and flowers mainly of honeylocust, privet and pines.

BORERS

The larval stage of some beetles and moths are called borers because they tunnel into the buds, shoots, bark or wood of trees and shrubs. A few species will attack healthy trees, but most attack trees and shrubs already weakened or injured by some other cause. Often the presence of borers is not evident until it is too late to save the tree; therefore, prevention of injury is most important. Borers frequently girdle and kill branches or whole trees, weaken a tree and make it subject to wind damage, and

provide entrance courts for disease fungi. Borer injury is indicated by dark, discolored, dead areas with sap and sawdust-like borings clinging to bark or littering the ground.

Bronze birch borer, *Agrilus anxius*, attacks birch trees which have been injured or are in a weakened condition. The elongated white larva makes long winding tunnels just under the bark which show as spiral ridges around the branches and trunk.

Elm bark beetles are vectors of the Dutch elm disease fungus. The **Smaller European elm bark beetle**, *Scolytus multistriatus*, feeds in the crotches of small twigs, while the **Native elm bark beetle**, *Hylurgopinus rufipes*, attacks rough-barked branches and stems. Both species are small, brownish beetles about 3 mm long.

European pine shoot moth, *Rhyacionia buoliana*, attacks the buds and young shoots of various pines causing deformed and stunted trees. The larva is brown with a black head. The most important and permanent damage results from spring feeding. The adult is a small, orange-flecked moth usually active in late June and early July.

Lilac borer, *Podosesia syringae*, is a wasp-like moth. The larva bores into lilac, ash, mountain ash and privet.

Locust borer, *Megacyllene robiniae*, is a black and yellow beetle that feeds on the pollen of goldenrod in late summer. The larva is a fleshy, white grub that tunnels in the stems of black locust. Weakened trees break in the wind.

Locust twig borer, *Ecdytolopha insiticiana*, causes irregular fusiform galls on twigs of black and honey locust. In heavily infested areas seedling mortality may be high.

Maple petiole borer, *Caulocampis acericaulis*, tunnels in the leaf stems of maple, causing the leaves to break near the blade and fall.

Pales weevil, *Hylobius pales*, is a small, brownish weevil which feeds on the tender bark of twigs of pines, causing the terminals to turn brown and die (flagging).

Peachtree borer, *Sanninoidea exitiosa*, and **Lesser peachtree borer**, *Synanthedon pictipes*, attack various cultivated and ornamental *Prunus*. The adults of both are clear-winged moths. The former species works at the base of trees while the latter develops higher in the scaffold limbs.

Poplar-and-willow borer, *Cryptorynchus lapathi*, is a stout, black, rough-bodied snout beetle. The outer half of the wing covers is pink. The white, legless larva honeycombs the trunk and larger branches of willows and poplars.

Sugar maple borer, *Glycobius speciosus*, is a robust, black, long-horned beetle with five yellow bands on the wing covers. The fleshy white larva cuts deep channels in the wood. Cracked, swollen areas resembling cankers are external indications of infestation.

Twig pruner, *Elaphidionoides villosus*, breeds in the twigs of oak, hickory, maple, and several other hardwoods. The larva bores down the center of a twig, then severs the branch so that it breaks in the wind. Trees are disfigured but seldom killed.

White pine weevil, *Pissodes strobi*, is a small, brownish snout beetle that attacks only the vertical terminals of pines and spruce, killing at least two years' growth. Attacks result in crooked, forked or multiple-stemmed trees.

GALL MAKERS

Galls are abnormal vegetative growths produced by a tree as a reaction to insect irritations or stimuli, such as feeding, stinging, egg-laying, or injection of toxins. This reaction is generally beneficial to the pest rather than to the tree as it provides a protective feeding site. Galls vary greatly in size, color and complexity, but each insect species produces a characteristic gall formation. Galls may be formed on any part of a tree. Oaks and hickories are the favorite hosts for several hundred different gall insects. They adversely affect the appearance and shape of trees, and may kill leaves and branches, but whole tree killing is not common. Galls are produced by aphids, mites, midges, gall wasps, and sometimes by the larvae of beetles and moths.

APHIDS

Cooley spruce gall aphid, *Adelges cooleyi*, induces formation of elongate galls on the current year's shoots of Colorado blue, Engelmann, and Sitka spruce. In an alternate host, Douglas fir, it causes needles to twist and turn yellow, but does not form a gall.

Eastern spruce gall aphid, *Adelges abietis*, induces pineapple-shaped galls to form at the base of the current year's shoots of Norway, white, red and black spruce. Old galls remain attached for long periods, turning black and imparting a scraggly appearance to the tree.

Hickory gall aphid, *Phylloxera caryaecaulis*, produces almost spherical galls, about 16 mm in diameter, on the twigs and leaf stems of hickory. Girdled twigs die and break at the point where a gall occurs.

MITES

Ash flower gall mite, *Eriophyes fraxiniflora*, is active when the male flower buds of ash break in the spring. It feeds on the unfolding tissues, causing them to form irregular clusters of galls 12 mm in diameter.

Maple bladder gall mite, *Vasates quadripedes*, causes globular, wartlike galls to form on the upper surface of silver and red maple leaves. Heavy infestations may completely deform leaves but trees are seldom seriously injured. The related **Maple spindle gall mite**, *Vasates aceris-crummena*, produces slender fusiform galls about 5 mm long on the upper surface of sugar and silver maple leaves.

Pearleaf blister mite, *Eriophyes pyri*, causes formation of small blisters on leaves of pear, apple and mountain ash.

Walnut blister mite, *Aceria erinea*, feeds on the underside of walnut and butternut leaves, causing yellow or brown feltlike galls there.

MIDGES

Honeylocust pod gall, *Dasyneura gleditschiae*, is caused by a mosquito-like insect. Eggs are laid on new leaflets and the larva feeds on the inner surface, causing formation of a pod-like structure. There are several generations a year.

Oak galls The roots, bark, twigs, leaves, flowers and acorns of oaks are very subject to infestation by a large number of gall makers. Each gall has a characteristic appearance and many are quite conspicuous and interesting. Few, however, cause serious damage.

SOIL PESTS

Pests attacking plants below the soil line can be particularly troublesome because, like borers, they are concealed from view, and extensive damage may be inflicted before their presence is detected. The extent of the pest problem, as to area infested and numbers involved, is difficult to determine, and the effectiveness of control treatments is equally difficult to assess. Soil pests are readily spread to new areas in balled nursery stock.

Black vine weevil, *Otiorhynchus sulcatus*, is also referred to as the taxus weevil because it is commonly associated with various species of *Taxus*. The larva is a small, white, legless grub which eats the fibrous roots or strips the bark of larger roots. Infested plants grow slowly or fail to grow, look dry and off-color, and transplants frequently die without becoming established. The adult is a black snout beetle which hides in the soil litter during the day and cuts crescent-shaped notches in the margins of the needles at night. The beetles are incapable of flight as the wing covers are fused. Arborvitae, hemlock, azaleas and rhododendrons are also attacked.

Nematodes are tiny threadlike roundworms that feed and multiply in or on roots of a wide range of plants. Feeding sites are indicated by necrosis (small dead areas) or by local increases in the size and number of cells. Nematodes may also spread soilborne viruses or facilitate secondary infection by bacteria and fungi. Nematode diseases of plants are controlled by crop rotation, by sterilizing the soil, or by disinfecting dormant planting material. Materials registered in Canada for control of nematodes on ornamentals and shrubs are Vorlex, chloropicrin, Basamid, Vapam, Telone, Methyl-Bromide. Use any of these materials according to the directions on the manufacturer's label.

"Factsheets are also available on: *Agdex 628-Soil and Root Sampling for Nematode Analysis*; *Agdex 628-Nematode Control Guidelines for the Application of Soil Fumigants*; and *Agdex 606-Soil Fumigants*".

Areas that harbor potential nematode problems should be treated before planting. For details concerning nematode problems, preplant soil fumigation, and the fumigation of established nurseries, consult your nursery specialist.

PEST CONTROL

Host Plant	Pest	Control+	Remarks
APPLE (*Malus*)	Aphid	malathion 500% EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240% EC, 1.75 L Cygon 480 E, 1.25 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Treat when adults are first seen and repeat as required. Do not apply to edible fruit crops.
	Cankerworm	Sevin 80% S, 2.25 kg Sevin 50% WP, 2 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L Thuricide, 1.5-2.0 L Dipel, 500 g Orthene 75% SP, 1 kg	Treat when larvae appear (about mid-May). See label. Do not apply to edible fruit crops.
	Eastern tent caterpillar	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L diazinon 500 EC, 925 mL Thuricide, 1.5-2.0 L Dipel, 500 g. Orthene 75% SP, 1 kg Dursban 2E, 1L Ambush 500 E.C., 70 ML	Eggs hatch about the time buds break in spring. Treat at this time or at first sign of webs. In light infestations remove and destroy tents which contain larvae. See label. Do not apply to edible fruit crops. See page 9 re Pesticide Resistance
	Leafroller	methoxychlor 240 EC, 4.0 L [2]Guthion 240 SC, 1.75-2.5 L Orthene 75% SP, 1 kg [2]APM 50% W, 1.0-1.25 kg	Apply to foliage soon after leaves have unfolded (about early June). Do not apply to edible fruit crops.
	Leafhopper	[2]Guthion 240 SC, 1.75-2.5 L [2]APM 50% W, 1.0-1.25 kg Imidan 50% WP, 1.25 kg Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L Orthene 75% SP, 1 kg	Leafhoppers may migrate to nursery stock. Check regularly for infestations and treat as required. Do not apply to edible fruit crops.
	Oystershell scale and San Jose scale	superior oil, 20 L ethion superior oil, 20 L diazinon 500 EC, 1.25 L malathion 500 EC, 2.5. L Orthene 75% SP, 1 kg	Use superior oil or ethion superior oil as a dormant treatment. Use any of other materials against crawlers about May 25 and again in 10 days. Do not apply to edible fruit crops.

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[2]Minimum period before reentry is 48 hours.

Host Plant	Pest	Control +	Remarks
APPLE (*Malus*) (continued)	European red mite and Two-spotted mite	superior oil, 20 L ethion superior oil, 20 L Plictran 50% WP, 250-375 g	Use as a dormant treatment in early spring. Do not apply more than 4 sprays per season.
ARBORVITAE (*Thuja*)	Arborvitae leafminer	Cygon 480 E, 2.5 L malathion 500 EC, 2.5 L lindane 25% WP, 4.0 kg	Spray in early May or late August with Cygon to control larvae. Use malathion or lindane in June to control moths.
	Bagworm	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Cygon 480 E, 2.5 L diazinon 500 EC, 1.25 L malathion 500 EC, 1.25 L Dylox 80% SP, 1.25 kg Orthene 75% SP,1 kg	Treat when "worms" are small (about early June). In light infestations hand-pick and destroy "bags" during fall and winter or early spring.
	Black vine weevil	See under YEW	
	Fletcher scale	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg diazinon 500 EC, 1.25 L Cygon 480 E, 2.5.L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg Dursban 2E, 4L	Use against crawlers (early July or September).
	Juniper scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.25 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg Dursban 2E, 4L	Use against crawlers (about early July and repeat in 10 days).
	Lecanium scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.25 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg Dursban 2E, 4L	Use against crawlers (about mid-July).
	Mite	Cygon 480 E, 2.5 L malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg Dursban 2E, 750-1000 mL Pentac Aquaflow, 400 mL Other materials specific for mite control are available. See page 20 re miticides.	More than two sprays are required.

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Host Plant	Pest	Control+	Remarks
ASH (*Fraxinus*)	Ash flower gall mite	superior oil, 20 L ethion superior oil, 20 L Morestan 25% WP, 1.0 kg malathion 25% WP, 2.0 kg	Use superior oil or ethion superior oil as a dormant treatment. Use other materials when first blossoms begin to form.
	Borer	*Thiodan 4 EC, 1.25 L Dursban 2E, 1 L	Treat trunk and large branches when pupae are observed projecting from tunnels. Repeat application in two weeks.
	Lacebug	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 1.25 L [2]Guthion 240 SC, 1.75-2.5 L [2]APM 50% W, 1.0-1.25 kg Orthene 75% SP, 1 kg	Apply to underside of leaves when insects first observed.
	Fall webworm	Chemical control is seldom required. Webs and caterpillars may be removed by hand. If sprays are necessary, apply one of the materials listed for Tent Caterpillars. See under APPLE.	
	Oystershell scale	superior oil, 20 L ethion superior oil, 20 L diazinon 500 EC, 1.25 L malathion 500 EC, 2.5. L Orthene 75% SP, 1 kg Dursban 2E, 4 L	Use superior oil or ethion superior oil as a dormant treatment. Use any of other materials against crawlers about May 25 and again in 10 days.
BEECH (*Fagus*)	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L [2]Guthion 240 SC, 1.75 L [2]APM 50 W, 1.0-1.25 kg Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Treat when aphids are first seen and repeat as needed.
	Cankerworm	See under APPLE.	
BIRCH (*Betula*)	Aphid	See under BEECH. Also Cygon 480 E, 625 mL Pirimor 50% WP, 500 g	
	Birch leafminer	Di-Syston 15% granules, (see label) Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L Meta-Systox-R 240 EC, 1.75 L Cygon 480 E, 500 mL Orthene 75% SP, 1 kg	Use any of materials listed in mid-May and again in late June. Cygon or Meta-Systox-R may be used after mines appear. Cygon 2E may be used as a soil drench or "brush-on" treatment. See label.

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Host Plant	Pest	Control+	Remarks
Birch (continued)	Birch skeletonizer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Thoroughly cover underside of leaves about mid-August.
	Bronze birch borer		Chemical control is very difficult. Cut and destroy weakened limbs by mid-May.
	Gypsy Moth	Sevin 50W, 2 kg Sevin 80S, 2.0 kg Orthene 75% SP, 850 kg Thuricide HPC, 1.6 L	Spray when damage first appears and repeat as required. Spray when leaf expansion reaches 40-50%. If necessary, spray about 14 days later.
BUTTERNUT WALNUT (*Juglans*)	Walnut blister mite	Kelthane 18.5% EC, 2.5 L	Apply to underside of newly formed leaves.
	Walnut caterpillar	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L	Spray when worms first appear, usually in July. Spray or remove worms clustering on trunk.
CHAMAECY-PARIS (*Chamaecy-paris*)	Mite	See under ARBORVITAE.	
CHOKE CHERRY and WILD CHERRY (*Prunus*)	Eastern tent caterpillar	See under APPLE.	
	Leafroller	See under APPLE.	
	Uglynest caterpillar	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Chemical control seldom undertaken. A pest only on low-growing shrubs.
DOUGLAS FIR (*Pseudotsuga*)	Cooley spruce gall aphid	See under SPRUCE.	
ELM (*Ulmus*)	Aphid	See under BEECH.	
	Cankerworm	See under APPLE.	
	Elm bark beetle	methoxychlor 240 EC, 80.0 L Dursban 4E, 10 L	Treat on suitable days in March and April before leaves are on trees. Apply second treatment around end of July.
	Elm casebearer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L	Treat foliage in early June.

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Host Plant	Pest	Control+	Remarks
Elm (continued)	Elm flea beetle	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat foliage in early June to control larvae, or in August to control adult beetles. Causes a shothole appearance to the leaves.
	Elm leafminer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L	Treat foliage around first of June to control larvae.
	Elm leaf beetle	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L *Thiodan 4 EC, 1.25 L Orthene 75% SP, 1 kg	Treat both upper and lower surfaces of leaves.
	European fruit lecanium	superior oil, 20 L ethion superior oil, 20 L Sevin 80% S, 1.25 kg Sevin 50% WP, 2.0 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use other materials as foliar spray to control crawlers (about mid-July).
	European red mite	See under MOUNTAIN ASH.	
	Leafhopper	See under HONEYLOCUST.	
FIR (*Abies*)	Balsam twig aphid	malathion 500 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L	Treat when aphids are first seen (about early May).
	Spruce budworm	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Ambush 500 EC, 35-70 ml	Apply general coverage spray to control larvae (about mid-May). See page 9 Pestcide Resistance.
HAWTHORN (*Crateagus*)	Eastern tent caterpillar	See under APPLE.	
	Gypsy Moth	See under BIRCH	
	Hawthorn leafminer	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat upper surface of foliage to control larvae in early June.
HEMLOCK (*Tsuga*)	Black vine weevil (Taxus weevil)	See under YEW.	

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Host Plant	Pest	Control+	Remarks
HICKORY (*Carya*)	Hickory gall aphid	malathion 500 EC, 1.25 L Dursban 2E, 750 mL	Treat twigs and buds in spring before leaves develop.
	Walnut caterpillar	See under BUTTERNUT.	
	Lacebug	See under ASH.	
HONEY-LOCUST (including Moraine, Sunburst and Shademaster) (*Gleditsia*)	Cottony maple scale	See under MAPLE.	
	Leafroller	See under APPLE.	
	Honeylocust mite	Several materials (Kelthane, Plictran, Morestan, etc) specific for mite control are available. See page 20 re miticides. Dursban 2E, 750-1000 mL	Treat when mites are present and again in 10 days. Repeat procedure as needed. See label.
	Honeylocust pod gall	Chemical control is very difficult. Malathion or lindane applied to growing tips as growth starts in spring and repeated at 10-day intervals throughout the season may help.	
	Leafhopper	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L Meta-Systox-R 240 EC, 2.5 L [2]Guthion 240 SC, 1.75-2.5 L [2]APM 50 W, 1.0-1.25 kg Orthene 75% SP, 1 kg Dursban 2E, 2 L	Treat underside of leaves when leafhoppers are active (about mid-June) and repeat as needed.
	Lecanium scale	See under ARBORVITAE.	
	Rust mite	Kelthane 18.5% EC, 1.25 L Plictran 50% WP, 250-375 g	May cause bronzing to the foliage when under heavy infestation. Apply to both surfaces of foliage when mites are active (about mid-June) and repeat as needed.
	Thrips	See under PRIVET.	

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Host Plant	Pest	Control+	Remarks
HONEY-SUCKLE (*Lonicera*)	Honeysuckle aphid	malathion 500 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Pirimor 50 WP, 500 g	Life history in Ontario has not been studied. Materials, rates and timing of application are tentative. Apply spray as soon as leaves are expanded, and repeat at least once after 3-week interval.
JUNIPER (*Juniperus*)	Juniper looper	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Cygon 480 E, 2.5 L	Treat foliage when larvae are active (late August and September).
	Juniper midge	Cygon 480 E, 2.5 L	Treat foliage about mid-May when adults are present and/or drench soil under infested plants in late April.
	Juniper scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.25 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Use against crawlers (about late June and repeat as needed). Do not use malathion on savin or canaerti junipers.
	Juniper webworm	malathion 500 EC, 2.5 L diazinon 500 EC, 1.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Miticide may be added to prevent buildup of mites if Sevin or methoxychlor is used. See page 20 re miticides.
	Spruce mite	See under SPRUCE.	
LARCH (*Larix*)	Larch casebearer	malathion 500 EC, 2.5 L	Treat in early May and September.
	Larch sawfly	methoxychlor 240 EC, 4.0 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg	Treat foliage when larvae are about half-grown (sometime in July).
	Woolly larch aphid	malathion 500 EC, 2.5 L Meta-Systox-R 240 EC, 1.75 L	Treat foliage thoroughly when aphids first appear (about early May).
LILAC (*Syringa*)	Lilac borer	*Thiodan 4 EC, 1.25 L lindane 25% WP, 4.0 kg Dursban 2E, 1 L	Control is difficult. Treat bark of trunk and large branches, especially around wounds, about mid-May. Repeat twice at 10-day intervals. Cut and destroy infested wood before May.

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Host Plant	Pest	Control+	Remarks
Lilac (continued)	Lilac leafminer	Cygon 480 E, 1.25 L malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg	Treat as soon as leafminer activity is first observed, or make first application in early June and repeat 6 weeks later.
	Oystershell scale	See under ASH.	
LINDEN (*Tilia*)	Aphid	See under BEECH.	
	Cankerworm	See under APPLE.	
	Linden looper	malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat foliage at first sign of infestation.
	Twospotted spider mite	Kelthane 18.5% EC, 2.5 L Meta-Systox-R 25% EC, 1.75 L Plictran 50 WP, 250-325 g	Treat underside of leaves, beginning in early June and repeat as needed.
	Gypsy Moth	See under BIRCH	
LOCUST (*Robinia*)	Locust borer	lindane 25% WP, 4.0 kg *Thiodan 4 EC, 1.25 L Dursban 2E, 1L	Chemical control is difficult. Treat bark or trunk and larger branches to control adult beetles (from mid-August to late September).
	Locust leafminer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg	Treat foliage to control adult beetles (about early July).
	Locust twig borerc	Chemical control is not perfected. Cut and destroy infested twigs in August before larvae escape. Rake and destroy leaves in the fall to kill the pupae.	
MAPLE (*Acer*)	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Treat when adults are first seen and repeat as required.

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Host Plant	Pest	Control+	Remarks
Maple (*Acer*) (continued)	Cottony maple scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg Dursban 2E, 4 L	Use superior oil or ethion superior oil as dormant treatment in early spring but not on sugar and Japanese maple. Use other materials to treat thoroughly about first week of July, and repeat in 10 days. Cover lower surface of leaves with spray. Malathion should not be used on Crimson King Maple.
	Forest tent caterpillar	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L Thuricide 1.5-2.0 L Dipel, 500 g Orthene 75% SP, 1 kg Dursban 2E, 1L Ambush 500 E.C., 70 ML	Treat foliage to control larvae about mid- to late May. See label. See page 9 re Pesticide Resistance
	Greenstriped mapleworm	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Eggs hatch over an extended period. Spray coverage required from mid-June to late July.
	Leafhopper	See under APPLE.	
	Lecanium scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80% S, 2.25. kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg Dursban 2E, 4L	Use superior oil or ethion superior oil as dormant treatment in early spring. Use any of the other materials against crawlers about late July. Malathion should not be used on Crimson King Maple.
	Maple bladdergall mite Maple spindlegall mite Crimson erineum mite	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Specific miticide. See page 20 re miticides.	Use superior oil, or ethion superior oil as a dormant treatment in early spring, but do not use oil on sugar and Japanese maple. Apply malathion in spring when temperature is 20°C or higher. Malathion should not be used on Crimson King Maple.

Host Plant	Pest	Control+	Remarks
Maple (continued)	Maple petiole borer	No satisfactory chemical treatments have been worked out. Collecting and destroying infested fallen leaf stems before the larvae leave them will help reduce borer populations. Spraying the foliage and ground beneath the trees with malathion-methoxychlor mixture as adults are emerging in May might be effective.	
	Maple trumpet skeletonizer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Apply to undersurface of leaves about mid-July to mid-August.
	Sugar maple borer	*Thiodan 4 EC, 1.25 L lindane 25% WP, 4.0 kg	Treat bark thoroughly, particularly near rough bark, throughout July and August. Maintain trees in as vigorous a condition as possible.
	Woolly maple scale	malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg	Treat bark and twigs as buds show green in spring. Do not use Malathion on Crimson King Maple.
MOUNTAIN ASH (*Sorbus*)	European red mite	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Specific miticide. See page 20.	Use superior oil or ethion superior oil as a dormant spray in early spring. Use other materials about late May. See label.
	Mountain ash sawfly	methoxychlor 240 EC, 4.0 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L *Thiodan 4 EC, 1.25 L Dursban 2E, 1 L	Treat foliage to control larvae during June. Repeat treatment in areas where second generation may appear.
	Pearleaf blister mite	ethion superior oil, 20 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Apply ethion superior oil as a dormant treatment in the spring. Apply Sevin as a foliar spray.
	Rose chafer	See under ROSE.	
OAK (*Quercus*)	Aphid	See under BEECH.	
	Cankerworm	See under APPLE.	
	European fruit lecanium	See under ELM.	

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Host Plant	Pest	Control+	Remarks
OAK (*Quercus*) (continued)	Golden oak scale	superior oil,20 L ethion superior oil, 20 L Cygon 480 E, 2.5 L Orthene 75% SP, 1 kg Dursban 2E, 4L	Use superior oil or ethion superior oil as a dormant treatment in early spring. Apply other materials against crawlers (about late June).
	Kermes oak scale	superior oil, 20 L ethion superior oil, 20 L Sevin 80% S, 2.25. kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any of the other materials against crawlers beginning in late May and repeat as required.
	Lacebug	See under ASH.	
	Lecanium scale	See under ARBORVITAE.	
	Oak blotch leafminer	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Orthene 75% SP, 1 kg	Treat foliage to control larvae beginning about first week of June.
	Oak leaf gall	Chemical control usually not necessary.	
	Oak Leaftier	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Apply to control larvae when leaves are partially expanded.
	Oak red mite	Kelthane 18.5% EC, 2.5 L Orthene 75% SP, 1 kg Plictran 50 WP, 250-375 g	Treat upper surface of foliage from mid-June to mid-July.
	Oak skeletonizer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L	Treat foliage when damage is first seen, about mid-June and again in August.
	Orangestriped oakworm	malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Spray in August when larvae are young and concentrated on the lower branches.
	Twig pruner	Chemical control is difficult and not very practical. Collect and destroy fallen twigs by mid-May.	
	Gypsy Moth	See under BIRCH	

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Host Plant	Pest	Control+	Remarks
PACHY-SANDRA (*Pachysandra*)	Euonymus scale	superior oil, 20 L ethion superior oil, 20 L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg [2]Guthion 240 SC, 1.75-2.5 L [2]APM 50 W, 1.0-1.25 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any of other materials against crawlers about mid-June.
PINE (*Pinus*)	European pine shoot moth	Cygon 480 E, 2.5. L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg diazinon 500 EC, 1.5 L [2]Guthion 240 SC, 2.5 L [2]APM 50 W, 2 kg	Apply spray to area between buds on terminals and laterals in latter part of April. Spray terminals about July 10 to prevent injury the following year.
	Pales weevil	lindane 25% WP, 4.0 kg Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Apply to tender bark of seedlings and young shoots of larger trees in late August or April.
	Pine bark aphid	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Use superior oil or ethion superior oil to bark of trunk and branches as a dormant treatment in early spring. Do not apply oil on White Pine. Apply other materials in late May.
	Pine needle miner	No recommended chemical control.	
	Pine needle scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Cygon 480 E, 1.25 L Orthene 75% SP, 1 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Do not apply oil on White Pine. Use any one of other materials against crawlers about late May and early June.
	Pine root collar weevil	lindane 25% WP, 4.0 kg	Apply to bark at base of trunk and soil surface 20 cm out from trunk about mid-June.
	Pine sawfly	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L Cygon 480 E, 1.25 L Orthene 75% SP, 1 kg Dursban 2E, 1 L Ambush 500 EC, 35-70 ml	Treat foliage when larvae are small and first observed feeding. See page 9 Pestcide Resistance.

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[2]Minimum period before reentry is 48 hours.

Host Plant	Pest	Control+	Remarks
PINE (continued)	Pine spittlebug	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Dursban 2E, 175-300 mL	Treat when spittle mass is first evident (about latter half of May).
	Pine tortoise scale	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat twigs to control nymphs about late May.
	Pine webworm	methoxychlor 240 EC, 4.0 L	Apply spray under sufficient pressure to penetrate webbing of nest. In light infestations hand-pick or prune infested tips.
	Spruce mite	See under SPRUCE.	
	White pine aphid	malathion 500 EC, 2.5 L Cygon 480 E, 2.0 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Use against active stages in May.
	White pine weevil	lindane 25% WP, 4.0 kg methoxychlor 240 EC, 4.0 L	Spray only vertical terminals in April. Remove and destroy infested leaders in June.
PLUM, CHERRY, etc. (*Prunus*)	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Treat when adults are first seen and repeat as required.
	Eastern tent caterpillar	See under APPLE.	
	Peachtree and Lesser peachtree borer	*Thiodan 4 EC, 1.5 L	Make three applications, the first in late May or early June, the second three weeks later and the third three weeks after the second. Apply spray with a gun and cover the trunk and scaffold limbs thoroughly.
	Pearslug	Almost any insecticide, and even hydrated lime, will give effective control. Apply one of the materials listed for Eastern Tent Caterpillar. See under APPLE.	

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Host Plant	Pest	Control+	Remarks
POPLAR (*Populus*)	Forest tent caterpillar	See under MAPLE.	
	Poplar and willow borer	*Thiodan 4 EC, 1.25 L lindane 25% WP, 4.0 kg Dursban 2E, 1 L	Treat bark of trunk and branches about mid-August and September.
	Gypsy Moth	See under BIRCH	
PRIVET (*Ligustrum*)	Lilac leafminer	See under LILAC.	
	Privet rust mite	Kelthane 18.5% EC, 2.5 L Morestan 25% WP, 1.25 kg Plictran 50% WP, 250-375 mL	Treat both surfaces of leaves when mites are first seen (in late May) and repeat as required.
	Privet sawfly	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L	Treat foliage when feeding damage is first observed.
	Thrips	Sevin 80% S, 2.25. kg Sevin 50% WP, 2.0 kg [2]Guthion 240 SC, 1.75-2.5 L Meta-Systox-R 240 EC, 1.75 L methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg Dursban 2E, 1 L	Treat at first sign of infestation and repeat as needed.
ROSE (*Rosa*)	Aphid	See under BEECH. Also Cygon 480 E, 1.25 L Pirimor 50% WP, 500 g	
	Leafhopper	See under HONEYLOCUST.	
	Rose chafer	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Treat foliage thoroughly when beetles are present in June.
	Roseslug	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat both surfaces of foliage from late May to mid-June.
	Twospotted spider mite	Kelthane 18.5% EC, 2.5 L diazinon 500 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Cygon 480 E, 1.25 L Orthene 75% SP, 1 kg Plictran 50 WP, 250-375 g	Treat undersurface of foliage beginning in early June and repeat as needed.

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+ Amounts shown are for 1000 L of spray.

Host Plant	Pest	Control+	Remarks
SPRUCE (*Picea*)	Cooley spruce gall aphid	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg Meta-Systox-R 240 EC, 1.75 L malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Dursban 2E, 750 mL	Apply early in spring before budbreak, or in early October. Cover thoroughly crevices in bark of terminal twigs and bases of buds. Use only wettable powders on Blue Spruce to avoid discoloration of foliage.
	Eastern spruce gall aphid	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Dursban 2E, 750 mL	Use superior oil or ethion superior oil as a dormant treatment. Use any of the other materials when aphids are migrating to new shoots (about mid-May). Do not use superior oil or ethion superior oil on Blue Spruce.
	Pine needle scale	See under PINE.	
	Spruce budworm	malathion 500 EC, 2.5 L Cygon 480 E, 1.25 L Lannate L, 1.25-1.75 L Ambush 500 EC, 35-70 ml	Apply general coverage spray to control larvae about mid-May. See page 9 Pestcide Resistance.
	Spruce bud scale	malathion 500 EC, 2.5 L	Spray to control the crawlers about July 10 and repeat after 10-day interval.
	Spruce spider mite	superior oil, 20 L Cygon 480 E, 1.25 L malathion 500 EC, 1.25 L Orthene 75% SP, 1 kg Dursban 2E, 750-1000 mL Pentac Aquaflow, 400 ml Specific miticide. See page 20 re miticides.	Use superior oil as a dormant treatment in early spring. Apply two sprays of other materials at 10-day intervals when mites are present during summer. More than two sprays of malathion may be required. Do not use superior oil on Blue Spruce. See label.
	Spruce needleminer	malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg	Apply to foliage about mid-June and repeat in late June.
	White pine weevil	See under PINE.	
TULIPTREE (*Liriodendron*)	Tuliptree aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L	Treat when aphids first appear and repeat as needed.

**Thiodan is very toxic to fish. Do not apply on or near water.*

Host Plant	Pest	Control+	Remarks
TULIPTREE (continued)	Tuliptree scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80% S, 2.25. kg Sevin 50% WP, 2.0 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any one of other materials when crawlers are present (usually in August).
VIBURNUM (*Viburnum*)	Snowball aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL Pirimor 50% WP, 500 g	Treat foliage when aphids are first seen (about mid-May) and repeat as needed.
WALNUT	See BUTTERNUT. (*Juglans*)		
WILLOW (*Salix*)	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Meta-Systox-R 240 EC, 1.75 L Orthene 75% SP, 1 kg Dursban 2E, 750 mL	Treat when aphids are first seen and repeat as needed.
	Imported willow leaf beetle	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L Orthene 75% SP, 1 kg	Treat at first sign of leaf feeding and repeat as needed.
	Oystershell scale	See under ASH.	
	Poplar and willow borer	See under POPLAR.	
	Spiny elm caterpillar	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg malathion 500 EC, 2.5 L	Treat when caterpillars are first seen and still small.
	Willow flea weevil	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat to control adults about the first of June, or when larvae begin feeding (about mid-June).
	Gypsy Moth	See under BIRCH	
YEW (*Taxus*)	Black vine weevil (Taxus weevil)	Chlordane 800 EC, 2.5 L *Thiodan 4E, 1.75 L	Treat foliage, bark of trunk, branches and surface of ground near trunk. Treat in last week of June and early July, or whenever grubs are noticed in soil. Do not use Thiodan on Anderson Yew.

**Thiodan is very toxic to fish. Do not apply on or near water.*

Host Plant	Pest	Control+	Remarks
	Fletcher scale	See under ARBORVITAE.	
	Lecanium scale	See under ARBORVITAE.	
	Taxus mealybug	malathion 500 EC, 2.5 L Cygon 480 E, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg diazinon 500 EC, 1.25 L	Use on bark of small branches and twigs to control nymphs (about last week of May to mid-June).

DISEASES AFFECTING TREES AND SHRUBS

Diseases are grouped below into five main categories: Foliage, Cankers, Vascular Wilts, Virus and Physiogenic (or noninfectious). Brief descriptions of major specific diseases within these categories are included.

FOLIAGE DISEASES

The most obvious signs of disease problems are reflected in the foliage. Very frequently, however, leaves will wilt, turn yellow or partly brown, become spotted, drop off, or become deformed, showing symptoms of diseases which are not directly associated with the leaves at all. This change in foliage condition is sometimes a response to disease problems such as vascular wilts or cankers which occur elsewhere on the plant. Noninfectious diseases such as those caused by drought and air pollution also show up first in the foliage.

Below are described the four types of diseases which infect the foliage directly. Rust diseases which cause leaf spots on broadleaf hosts are discussed under **Cankers**.

POWDERY MILDEW

Powdery mildew diseases are caused by fungi. The fungi grow mainly on the surface of the leaves and can be seen as a greyish layer. The disease affects many woody ornamentals including lilac, rose, privet and catalpa. A number of different fungi are responsible; some attack only one or a few kinds of plants while others attack many different plants. The fungus may not spread readily from one kind of plant to another because the strain of the fungus that attacks one type may not attack the other. Powdery mildews produce spores in powdery masses over the leafy surface and are wind-borne to cause secondary infections. They usually become apparent after mid-season when cooler nights are followed by warm days.

Because the fungus grows mainly on the surface on the plant it is readily contacted by fungicides applied to the surface. In some cases, as in roses, severe deformation can occur and control is necessary. In others, such as lilac and privet, the disease is usually not sufficiently damaging to warrant application of fungicides.

GREY MOLD (BOTRYTIS BLIGHT)

This fungus disease may affect bulbs, stems, leaves and flowers. High humidity caused by crowding the plants, poor ventilation and leaving old leaves and flowers on the plants or soil surface all encourage an outbreak of Botrytis. Symptoms vary from host to host. If the air is very humid the organism develops a fuzzy grey growth on infected plant parts.

LEAFSPOTS AND ANTHRACNOSE

A great many organisms, mostly fungi, can infect foliage, causing anthracnose or spotting, the coalescence of the spots as infection spreads and, in severe cases, defoliation. Among the more common fungi causing leafspots are: *Gleosporium, Alternaria, Cercospora, Phyllosticta, Coccomyces, Marssonina, Gnomonia, Cladosporium, Mycrostroma, Glomerella, Septoria, Mycosphaerella, Guignardia.*

Hosts frequently infected by one or more of the above are catalpa, poplar, walnut, hickory, hawthorn, maple, oak, sycamore, mock-orange, mountain ash, and horse chestnut.

Intensity of infection by leafspotting fungi is most determined by weather conditions in the spring, when new growth is tender and succulent. Disease severity increases with the persistence of cool, wet, dull weather.

Leafspots are usually more unsightly than harmful. However, extensive defoliation in successive years can be debilitating, leading to decline and death. Such is the case with sycamore anthracnose caused by the fungus *Gnomonia plantani*. It can be particularly severe in Ontario and has caused extensive mortality in the eastern United States in years past. This disease also affects the twigs, causing a canker.

NEEDLECAST

Pines and firs (*Abies*) are susceptaible to needlecast diseases caused by various fungus species of *Hypodermella, Bifusella, Lophodermium* and *Hypoderma*. Infection takes place just after new growth has begun and causes needles to die and fall off, after which the characteristic black fruiting bodies develop along the needles. Needlecast can be of serious consequence in one- to four-year-old plants in forest tree nurseries where chemical control is recommended.

SCAB

Diseases which cause scab-like lesions are frequent on rosaceous plants like crabapples. The term "scab" usually describes a disease as it appears on the fruits, although the associated fungi usually also cause a leafspot similar to Blackspot of rose. Apple scab (*Venturia inaequalis*) has caused extensive defoliation of crabapples because of the cool, wet weather often encountered in May and June. In most years, Apple scab does not require chemical control.

Spraying for Pyracantha scab *Venturia pyracanthae*, which destroys the fruit of susceptible varieties of Firethorn, is necessary in most years. The cultivars "Orange Glow", "Orange Charmer" and "Mohave" are resistant.

CROWN AND ROOT ROTS

All the fungi described below are soil inhabitants. *Pythium* and *Phytophthora* fungi cause a rotting of the roots and crowns of many plants. The lower part of the leaf and petioles and stems of diseased plants have a water-soaked appearance. Eventually the entire plant will rot off at the ground level. *Rhizoctonia* and *Fusarium* fungi cause a brown cankering of the below ground stem and roots of infected plants. *Thielaviopsis* causes a severe rotting of the roots of infected plants. The affected areas are more black in color than brown.

CANKERS

The term "canker" refers to a disease of woody plants that causes the death of bark tissues in relatively localized areas of branches and stems. Death of bark and cambium is followed by death of the underlying wood, and the bark in these areas splits as it dries and can easily be removed, exposing the wood below. Although most cankers are associated with fungi, sun scald and frost can cause similar symptoms. Usually on the dead bark areas are formed the fruiting "pustules" of the disease organism.

A great many canker diseases are caused by weak, parasitic fungi which would be thrown off by normal host reactions, under conditions of good health and vigor. However, when the host is in a weak condition due to many causes — drought, lack of hardiness, root disturbance, poor root environment, etc. — it lacks the capacity to "seal off" the infection and the disease gets a foothold on the tissue and can cause serious damage. Cankers of this nature are very common, but are a secondary response and a reflection of host vigor. Plants prone to such cankers are maple, poplar, spruce, willow, daphne, rosaceous hosts, and especially mountain ash. Common, weak, parasitic fungi are species of *Cytospora, Nectria, Valsa, Hypoxylon.*

Some canker diseases are more serious and are, in some cases, aggravated by monoculture growing systems, such as those found in plantations and forest nurseries. In other cases, they result from the sudden introduction of diseases to non-resistant hosts, such as the cankers white pine blister rust (which is covered under **Rusts**) and chestnut blight.

Chestnut blight, caused by the introduced fungus *Endothia parasitica*, has effectively destroyed all our native sweet chestnut (*Castanea dentata*) which grew in Southern Ontario. There is no satisfactory control of infection, although Oriental chestnuts are resistant.

Canker diseases may be either annual or perennial. Their action is not one of merely causing dead patches of bark, but rather of spreading through bark tissues to girdle the stem or branch, killing the distal portions of the plant. Annual cankers can girdle small stems and twigs, such as those of cherry, dogwood and sycamore.

For the most part, cankers are controlled by physical removal of cankered areas, i.e. pruning-out of diseased branches well below the affected areas, or treating stem cankers as wounds to encourage callusing and eventual healing. Where cankers are caused by weak parasites, improving the vigor of the host by cultural means is essential for long-term control. Except as noted below, chemical control is not recommended. Considered separately below are the important canker diseases, such as Rust, Fire blight, Crown Gall.

RUSTS

Rust diseases are caused by fungi. The diseases are visible as reddish-brown (rusty) spots on leaves, twigs or stems. Rusts usually have two hosts, spending part of their life cycle on one kind of plant and part on another kind; both are essential for completion of the life cycle. The shape of infected plant parts is frequently distorted, although one host plant may be severely damaged while the other one only slightly damaged.

The most important group of rust fungi in woody ornamentals is the *Gymnosporangium* rusts. *G. juniperi-virginianae* attacks apple and red-cedar; *G. clavariaeforme* attacks *Juniperus virginiana, Amelanchier, Aronia, Cydonia* and *Pyrus*; *G. globosum* attacks *Crataegus* and *Sorbus*; and *G. clavipes* attacks *Crataegus* and *Chaenomeles.*

Cedar-apple rust (*G. juniperi-virginianae*) spends part of its life on red-cedar and another part on apple (*Malus*). It may occasionally severely damage flowering crabapple, whereas red-cedar is rarely severely affected unless several hundred galls are formed on a single tree.

Simply pruning out the galls is the only recommendation on the *Juniperus* host, but a fungicide spray program may be recommended on the broad-leaved hosts. Separation of the two hosts as far as possible reduces the intensity of infection.

White Pine blister rust (*Cronartium ribicola*) is a serious disease of five-needle pines, particularly native White Pine (*Pinus strobus*). It infects the needles and eventually causes a perennial canker on branches and stems. Alternate hosts are gooseberries and currants (*Ribes* spp.), where it causes a leafspot of relatively little significance. Girdled branches of pine should be pruned out before the canker reaches the main stem. Separation of the two hosts is a recommended control. Pine plantations and nurseries should be cleared of *Ribes* for a distance of about 600 metres.

Sweetfern blister rust (*Cronartium comptoniae*) has caused serious losses in nurseries and young plantations of hard pines, especially Jack Pine (*P. banksiana*). The alternate hosts are Sweetfern and Sweetgale (*Myrica* spp.). Areas around nurseries should be cleared of *Myrica* for several hundred yards. Diseased pines should be destroyed.

FIRE BLIGHT

Fire blight is caused by the bacterium *Erwinia amylovora.* It causes disease in many members of the Rosaceae including *Amelanchier, Aronia, Chaenomeles, Cotoneaster, Crataegus, Malus, Photinia, Prunus, Pyracantha, Pyrus, Sorbus* and *Spiraea.* Flowers, spurs, twigs and leaves turn brown and dry out. Dead leaves remain on the plant and appear as though scorched. In warm, humid weather an amber-colored material may exude from recently infected parts. Bleeding perennial cankers may appear on limbs, trunk or roots as infection spreads. The bacteria are spread from one plant to another by rain, wind and insects.

Control practices include bactericidal sprays at flowering, pruning out cankers one foot below affected area, and removing sources of infection such as nearby neglected pear trees.

CROWN GALL

This is a bacterial disease caused by the bacterium *Agrobacterium tumefaciens*. It causes galls with an irregular, rough surface ranging up to several centimetres, usually occurring near the soil line at the root collar, but sometimes found on the roots and aerial parts. It is not a true canker disease, but is included in this section because its effect is to disrupt the vascular system to such an extent that girdling results.

A great many plants are susceptible, including rosaceous hosts, euonymus and nut trees. Bacterial entrance is through wounds made by disc, hoe, grafting knife, etc., and the bacterium can remain alive in the soil in the absence of host plants for about two years. Chemical control is not recommended. Landscapers should not accept plants from the nursery which have suspicious bumps on the scaffold roots, especially roses and fruits. For nurseries, sanitary propagation practices, such as sterilized grafting tools, are necessary. Infested soils should be replaced, or left fallow for two years before reuse.

VASCULAR WILTS

Vascular wilt diseases are caused by fungi or bacteria that enter the water-conducting elements (vascular system) within the plant. Damage to the vascular system reduces the supply of water to the leaves and they wilt. In early stages of wilt the leaves can often recover temporarily during cool, moist periods, but eventually wilt becomes permanent and the leaves die. Death of leaves and twigs leads to branch mortality and to the eventual death of the entire plant. Important examples of vascular wilt diseases are: Dutch elm disease caused by the fungus *Ceratocystistis ulmi* and verticillium wilt of maple, linden and catalpa caused by *Verticillium dahliae*.

Since the disease organisms are deep inside the plant it is impossible to control the disease with a chemical that acts only at surface level. To avoid wilt diseases, use resistant varieties, if available, and plant in soil free from the disease organisms. Diseased plants with verticillium wilt can sometimes be maintained culturally by improving plant vigor through pruning, fertilizing and watering.

Dutch elm disease presents a special case in which attempts are made to control the elm bark beetles that carry the fungus from diseased trees to healthy ones. Removal of diseased and dead trees is essential to the control of beetle populations which breed in them.

In addition to sanitation, a treatment using a systemic fungicide is now recommended and is available in Ontario through qualified arborists. Involved is the pressure-injection of a water-soluble fungicide, carbendazim-phosphate, through severed roots of the tree or into the root flare. This treatment offers two years' protection and the root injection will rid a tree of the disease in early stages of infection.

VIRUS DISEASES

Virus diseases cannot be controlled directly by chemical means. Most virus diseases are spread by insects or infected tools (pruning equipment, knives, shears). Control of such insects as aphids, leafhoppers, mites and other migratory insects will aid in preventing the spread of a virus disease.

Where a virus is suspected, all tools should be disinfected before being used again.

Virus diseases may appear on plants as mottled yellow foliage, misshapen or wrinkled leaves or aborted flowers. In some plants, an overall stunting of growth occurs. Such plants should be removed and destroyed.

PHYSIOGENIC DISEASES

Physiogenic diseases are those not caused by a living organism or virus. They principally affect the foliage and/or proper functioning of root systems. In the latter, a gradual dieback and even an eventual mortality can occur. Physiogenic diseases are the base causes of vast numbers of plant problems, often predisposing plants to infection by secondary disease organisms. Such disorders and diseases are commonly caused by weather conditions, soil conditions, and man-made physical and chemical disturbances to the air and soil environments.

A common example is leaf and root scorch caused by high levels of salt in the soil, the result of salty irrigation water or from salt applied to remove snow and ice. A late spring leaf scorch of maple and beech has been attributed to sudden exposure of leaves to full sunlight following a wet, cloudy period.

The response to changes in the rooting environment varies with the age and kind of plant, and the nature and intensity of these changes. Oak, maple, ash and spruce are particularly sensitive, and have a low capacity to adjust to new conditions, such as soil compaction, drought, excessive water, change in soil level, root damage during construction, etc.

Control measures for physiogenic diseases primarily depend on eliminating or avoiding the damaging factors, as in salt injury, obtaining resistant plant material, or otherwise improving the growing conditions.

DISEASE CONTROL

Host Plant	Pest	Control+	Remarks
APPLE (*Malus*)	Cedar-apple rust	ferbam 76% WP, 1.25-2.25 kg Polyram 80% WP, 2.0 kg zineb 80% WP, 1.25 kg	Make 2 applications to foliage about May 10 and May 20.
	Fire blight	streptomycin sulfate, 100 ppm Bordeaux mixture, 3-5-1000	Use in areas where fire blight is a recurring problem. Spray at early bloom, full bloom and petal fall.
	Scab	Cyprex 65% WP, 500 g benomyl 50% WP, plus mancozeb 80% WP, 550 g + 3.25 kg Polyram 80% WP, 2.0 kg captan 50% WP, 2.0 kg	
ASH (*Fraxinus*)	Dieback	See "Physiogenic Diseases", page 41.	
CATALPA (*Catalpa*)	Leafspot	No chemical control.	
CHERRY, PEACH, FLOWERING ALMOND (*Prunus*)	Blossom and twig blight	sulfur 90-95% WP, 2.0 kg captan 50% WP, 2.0 kg Cyprex 65% WP, 500 g benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg	Spray just before blossom buds open. Repeat in 10 days if wet weather persists.
	Black knot	Prune infected twigs and branches several centimetres below knots and destroy them.	
DOGWOOD (*Cornus*)	Twig blight	Prune infected twigs and branches back to healthy wood. Improve cultural conditions.	
ELM (*Ulmus*)	Dutch elm disease	See "Elm Bark Beetle", page 26, and "Vascular Wilts", page 41. Systemic fungicide treatment now available.	
EUONYMUS	Crown gall	See "Crown Gall", page 40.	
FIR (*Abies*)	Canker	See "Cankers", page 40.	
FIRETHORN (*Pyracantha*)	Needlecast	Fixed copper 50% WP, 4.0 kg Bordeaux mixture, 8-8-1000	Principally a nursery disease. Spray after new growth has started and again 10 days later.
	Scab	See under APPLE.	Spray at full flower and repeat twice at 14-day intervals. A mid-August spray may be needed under cool, wet conditions.

+ *Amounts shown are for 1000 L of spray.*

Host Plant	Pest	Control+	Remarks
HAWTHORN (*Crataegus*)	Leaf rust	See under APPLE.	
	Leafspot	See under CATALPA.	
	Scab	See under APPLE.	
	Fire blight	See under APPLE.	
HICKORY (*Carya*)	Leafspot	See under CATALPA.	
HORSE-CHESTNUT (*Aesculus*)	Leaf scorch	See "Physiogenic Diseases", page 41.	
	Leafspot	See under CATALPA.	
JUNIPER (*Juniperus*)	Cedar-apple rust	Prune out galls on infected branches in April. Separate from rosaceous hosts as far as possible. See under "Rusts", page 40.	
	Blight (canker)	fixed copper 50% WP, 4.0 kg	Primarily a nursery disease. Fungus seldom found associated with symptoms in older plants in Ontario, suggesting other causes. Spray at start of spring growth and at 10-day intervals until growth ceases.
LILAC (*Syringa*)	Powdery mildew	sulfur 90-95% WP, 6.0 kg benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg	Spray at 10- to 14-day intervals beginning about August 20.
	Bacterial twig canker		Prune out infected twigs. Kills young twigs in wet springs.
LINDEN or BASSWOOD (*Tilia*)	Canker	See "Cankers", page 40.	
	Verticillium wilt	See under MAPLE. Also "Vascular Wilts", page 41.	
MAPLE (*Acer*)	Verticillium wilt	Prune wilted branches back to undiscolored wood. Thin out remainder of crown. Fertilize and water to promote vigor, especially root growth. Disease often followed by frost cracks and associated cankers. Systemic fungicides are promising. See also "Vascular Wilts", page 41.	
	Dieback	See "Physiogenic Diseases", page 41.	
	Leafspot	See under CATALPA.	

+ *Amounts shown are for 1000 L of spray.*

Host Plant	Pest	Control+	Remarks
	Canker	See "Cankers", page 40.	
	Leaf scorch	See "Physiogenic Diseases", page 41.	
MOUNTAIN ASH (*Sorbus*)	Fire blight	See under APPLE. Also "Fire blight", page 40.	
	Leafspot	See under CATALPA.	
	Canker	See "Cankers", page 40.	
	Apple scab	See under APPLE.	
OAK (*Quercus*)	Leafspot	See under CATALPA.	
	Dieback	See "Physiogenic Diseases", page 41.	
	Chlorosis	Especially Pin Oak. See "Fertilizing Landscape Plantings", page 14.	
PINE (*Pinus*)	Needlecast	See under FIR.	
	White pine blister rust	See "Rusts", page 40.	Separate 5-needle pines from *Ribes* co-host as far as possible. Prune infected branches 30 cm below cankered area. Remove stem cankers according to proper surgical procedures.
	Sweetfern blister rust	See "Rusts", page 40.	Principally a nursery and plantation disease of 2- and 3-needle pines. Separate pines from *Myrica* co-host as far as possible. Remove infected pines.
PLANE SYCAMORE (*Plantanus*)	Anthracnose	Mancozeb 80% WP, 2.75 kg	Apply up to 3 times depending on cool wet weather — as buds are swelling, at bud break, and about 7 days later. Prune out and destroy cankered twigs and branches.

+ *Amounts shown are for 1000 L of spray.*

Host Plant	Pest	Control+	Remarks
POPLAR and ASPEN (*Populus*)	Leafspot	See under CATALPA.	
	Canker	See "Cankers", page 40.	
PRIVET (*Ligustrum*)	Anthracnose and twig blight	No chemical control.	
QUINCE (*Chaenomeles*)	Fire blight	See under APPLE.	
ROSE (*Rosa*)	Black spot	benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg Daconil 2787 Flowable, 1.5-1.7 L	Spray at 10-to 14-day intervals beginning mid-May until mid-August and especially after rain. Shorten intervals in cool, wet weather.
	Botrytis	Botran 75W, 1.75 kg	Apply prior to lifting for storage. Repeat during storage.
	Powdery mildew	benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg sulfur 90-95% WP, 6.0 kg Meltatox, 2.5 L	Spray at 10-to 14-day intervals beginning about mid-July.
	Crown gall	See "Crown Gall", page 40.	
SPRUCE (*Picea*)	Canker	See "Cankers", page 40.	
	Dieback	See "Physiogenic Diseases", page 41.	
WALNUT (*Juglans*)	Leafspot	See under CATALPA.	
WILLOW (*Salix*)	Blight (scab and black canker complex)	No chemical control.	

+ *Amounts shown are for 1000 L of spray.*

INSECTS AND DISEASES AFFECTING ANNUALS AND PERENNIALS

A continuous, colorful display of annual and perennial plants throughout the growing season requires careful planning, not only in the choice of plant materials, but in the selection of the proper site, soil preparation, fertilization, and in the control of insect, disease and weed.

While this publication is directed toward the control of troublesome diseases, insect and related pests, complete success of bedding plant displays will only come when all the conditions for optimum growth are met.

Display beds for bulbs, perennials and annual plants are generally best situated in sunny areas, free from the competition of roots and the shade cast by larger woody plants. The soil should be of good quality, easily prepared and fertile. A soil test is the best means of determining proper fertility levels.

After the plants have become well-established following planting, regular biweekly feedings with a soluble fertilizer such as 20-20-20 will maintain good growth and vigor.

Good cultural practices can help to prevent disease and insect problems. Healthy, weed-free plantings are much less susceptible to attack by disease organisms or troublesome insect pests. However, such problems will require control under certain cultural or climatic conditions. The control can be determined by referring to the list of common diseases and insect pests which follows.

INSECT CONTROL

Pest	Host Plant	Control+	Remarks
Aphid	Begonia, Centaurea Dusty Miller, Cineraria, China Aster (*Callestephus*), Coleus, Geranium (*Pelargonium*), Impatiens, Salvia, Pansy (*Viola*), Snapdragon, Zinnia, Chrysanthemum, Campanula, Spring flowering bulbs, Gladiolus, Sunflower	malathion 500 EC, 1.25 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L diazinon 500 EC, 1.0 L Orthene 75% SP, 1 kg	Treat when seen. Repeat as required.
Beetle, Bug, Caterpillar	Alyssum, China Aster (*Callestephus*), Geranium (*Pelargonium*), Impatiens, Marigold (*Tagetes*), Pansy (*Viola*), Petunia, Salvia, Snapdragon, Zinnia, Chrysanthemum, Delphinium, Iris, Hollyhock (*Althea*), Phlox, Primula	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat when seen. Repeat as required.
Black vine weevil	Begonia	Chlordane 800 EC, 2.5 L	
Borer	Iris	Cygon 480 E, 1.25 L	Spray new foliage. Apply to soil around infested plants.

+ *Amounts shown are for 1000 L of spray.*

Pest	Host Plant	Control+	Remarks
Corn earworm	Ageratum, Gladiolus	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Treat as soon as insect is first seen.
Cutworm	Delphinium, Gladiolus	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	
Leafhopper	China Aster (*Callestephus*), Marigold (*Tagetes*), Zinnia, Hollyhock (*Althea*)	Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Spray when insects appear.
Leafminer	Columbine (*Aquilegia*), Chrysanthemum, Delphinium	malathion 500 EC, 2.5 L	Apply as soon as miners are noticed.
Leaf skeletonizer	Hollyhock (*Althea*)	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Treat when seen. Repeat as required.
Mealybug	Begonia, Coleus, Geranium (*Pelargonium*), Pansy (*Viola*), Primula	malathion 500 EC, 2.5 L	
Midge	Chrysanthemum	malathion 500 EC, 2.5 L	
Mite	Begonia, China Aster (*Callestephus*), Coleus, Geranium (*Pelargonium*), Pansy (*Viola*), Snapdragon, Zinnia, Chrysanthemum, Delphinium, Gladiolus, Hollyhock (*Althea*), Phlox, Primula	malathion 500 EC, 2.5 L Kelthane 18.5% EC, 2.5 L Cygon 480 E, 1.25 L Plictran 50 WP, 250-375 g	Treat as required, and repeat in 5-7 days.
Slug	Geranium (*Pelargonium*), Marigold (*Tagetes*), Pansy (*Viola*), Campanula, Delphinium, Primula	metaldehyde bait or 15% dust	Treat soil around plants.
Sawfly	Pansy (*Viola*)	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Treat when seen. Repeat as required.

Pest	Host Plant	Control+	Remarks
Thrips	Begonia, Campanula Chrysanthemum, Gladiolus, Iris (In garden)	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L Orthene 75% SP, 1 kg	Treat when seen. Repeat as required. Begin spraying Gladiolus when young plants are 30 cm tall and repeat at two-week intervals.
	Gladiolus (In storage)	Dust with 5% Sevin dust	Use dry storage at 2-4°C.
Tobacco budworm	Ageratum	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg methoxychlor 240 EC, 4.0 L	Treat as soon as insect is first seen.
Tarnished plant bug	Gladiolus	malathion 500 EC, 2.5 L Sevin 80% S, 2.25 kg Sevin 50% WP, 2.0 kg	Apply when flower buds begin to develop. Repeat just before buds open.
Whitefly	Ageratum, Begonia, Coleus, Geranium (*Pelargonium*), Salvia, Chrysanthemum	*Thiodan 4 EC, 1.25 L	
White grub, Wireworm	Gladiolus	Chlordane 800 EC, 7-14 L/ha	Do not plant Gladiolus for 2 years following sod as white grub and wireworm are likely to be prevalent. Use sufficient water to obtain thorough coverage.

DISEASE CONTROL

Anthracnose	Pansy (*Viola*) Snapdragon	Folpet 50% WP, 2.0 kg	Apply at 5-day intervals.
Blight, Leaf blight	Zinnia, Primula Snapdragon	ferbam 76% WP, 1.25-2.0 kg Folpet 50% WP, 2.0 kg	
Bacterial blight, Scab	Gladiolus (In storage)	No chemical control.	Destroy infected corms.
Bacterial soft rot	Iris	No chemical control.	Use clean or pasteurized soil and clean rhizomes. Also see Iris borer control.

**Thiodan is very toxic to fish. Do not apply on or near water.*

+ Amounts shown are for 1000 L of spray.

Pest	Host Plant	Control+	Remarks
Botrytis Botrytis leaf spot Fire (Botrytis)	Pansy (*Viola*), Snapdragon, Geranium (*Pelargonium*), Spring flowering bulbs	captan 50% WP, 2.0 kg Rovral 50% WP, 1 kg Daconil 2787 Flowable, 1.5-1.7 L	
Botrytis dry rot	Gladiolus (In garden)	No chemical control.	
Bulb rot	Spring flowering bulbs	No chemical control.	Use clean stock and clean or pasteurized soil.
Club root	Alyssum	No chemical control.	Use clean stock and clean or pasteurized soil.
Damping off	Alyssum	Vitavax Captan 30W, 250 g	Avoid overcrowding.
Downy mildew	Centaurea, Cineraria, Dusty Miller, Snapdragon	Fixed copper 50% WP, 4.0 kg Bordeaux mixture, 4-4-1000 benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg	
Fusarium wilt	Marigold (*Tagetes*), Gladiolus (In garden)	No chemical control.	Use clean stock only and clean or pasteurized soil. Remove infected plants.
Grey mold (Botrytis)	Chrysanthemum	zineb 80% WP, 1.25 kg captan 50% WP, 2.0 kg	
Leafspot	Chrysanthemum	Folpet 50% WP, 2.0 kg zineb 80% WP, 2.0 kg captan 50% WP, 2.0 kg	
	Begonia, Coleus, Impatiens, Marigold (*Tagetes*), Salvia, Campanula, Delphinium, Hollyhock (*Althea*), Iris, Phlox	Folpet 50% WP, 2.0 kg	
Powdery mildew	Begonia, Snapdragon, Chrysanthemum, Campanula, Delphinium, Phlox	sulfur 6.0 kg benomyl 50% WP, plus mancozeb 80% WP, 500 g + 2.25 kg	
Root rot	Ageratum, China Aster (*Callestephus*), Geranium (*Pelargonium*), Snapdragon, Zinnia	Truban, 270-375 g	Use clean or pasteurized soil. Practice crop protection.

+ Amounts shown are for 1000 L of spray.

Pest	Host Plant	Control+	Remarks
Rust	Chrysanthemum	Sulfur, 6.0 kg ferbam 76% WP, 1.5-2.0 kg	
	Ageratum, Centaurea, Cineraria, China Aster (*Callestephus*), Dusty Miller, Pansy (*Viola*), Salvia, Columbine (*Aquilegia*), Campanula, Hollyhock (*Althea*), Iris, Primula	Sulfur, 6.0 kg	
Scab	Pansy (*Viola*)	No chemical control.	
Soft rot, Corm rot, Hard rot, Dry rot	Gladiolus (in storage)	No chemical control.	Destroy infected corms. Avoid warm, humid storage conditions.
Stem canker	Delphinium	No chemical control.	Use clean or pasteurized soil.
Stem rot	Begonia	Truban, 270-375 g Quintozene 75% WP, 1.25 kg/100m^2	Use as a soil drench.
	China Aster (*Callestephus*), Impatiens, Petunia, Snapdragon, Zinnia	Truban, 270-375 g	Use clean or pasteurized soil. Use as a soil drench.
Tip blight and Leafspot	Dracaena (*Cordyline*)	No chemical control.	Remove affected leaves. Avoid wetting foliage.
Wilt	Alternanthera, Centaurea, Cineraria, Dusty Miller, China Aster (*Callestephus*), Impatiens, Snapdragon, Chrysanthemum	No chemical control.	Use clean or pasteurized soil.
Yellows	China Aster (*Callestephus*), Marigold	No chemical control.	Virus disease transplanted by leafhoppers which causes poor flowering, followed by distorted flowers and leaves yellowing and death. Destroy infected plants as soon as noticed.

+ *Amounts shown are for 1000 L of spray.*

INSECT AND DISEASES OF TURF AND THEIR CONTROL

Pest	Control	Rate Per $100m^2$	Use sufficient water for thorough coverage. Follow label direction
Ant	diazinon 500 EC	150 mL	Repeat in 7-10 days if necessary.
	Sevin 80% S	90 g	
	Sevin 50% WP	130 g	
	Dursban 2E	45 mL	
	Dursban G	450 g	Apply to lawn. Water in after treatment.
	Chlordane 800 EC	100 mL	
	Chlordane 25 G	250-440 g	
Hairy chinch bug	Sevin 80% S	90 g	Apply in July if damage was heavy the previous year, or apply when damage first noticed. Water area to be treated prior to application and irrigate immediately after. Not more than twice per season.
	Sevin 50% WP	130 g	
	diazinon 500 EC	150 mL	
	Dursban 2E	45 mL	
	Dursban G	900 g	
European chafer	Dursban 2E	90 mL	Apply to lawn. Water into soil. Control in late July and mid-September.
	Dursban G	900 g	
Japanese beetle	Chlordane 800 EC	100 mL	
	Dursban 2E	90 mL	
	Dursban G	900 g	
Cutworm	Sevin 80% S	90 g	Repeat in 7-10 days if necessary.
	Sevin 50% WP	130 g	
	Chlordane 800 EC	100 mL	Apply to lawn. Water in after treatment.
	Dursban G	900 g	Not more than twice per season.
Sod webworm	Chlordane 800 EC	55 mL	Do not water into soil.
	Chlordane 25 G	180-220 g	
	diazinon 500 EC	150 mL	
White grub and Wireworm	Chlordane 800 EC	100 mL	Apply to lawn. Water into soil after treatment.
	Chlordane 25 G	250-440 g	
	Dursban 2E	90 mL	
	Dursban G	900 g	

Pest	Control	Rate Per 100m²	Use sufficient water for thorough coverage. Follow label direction
Brown Patch (*Rhizoctonia*)	Thiram 80 % WP Daconil 2787 Flowable Dyrene 50% WP *Tersan 1991 WP 50 *Easout 70% WP Rovral 50 WP	90 g 95-190 mL 125 g 60 g 60 g 60 g	Rates for preventive schedule to be applied at intervals of 1-2 weeks during periods the disease is likely to develop.
Dollar Spot (*Sclerotinia*)	Thiram 80% WP Daconil 2787 Flowable Dyrene 50% WP Rovral 50 WP *Easout 70% WP *Tersan 1991 WP 50 CAD	90 g 95-190 mL 125 g 45 g 30 g 30 g 30 mL	Rates for preventive schedule to be applied at intervals of 1-2 weeks during periods the disease is likely to develop.
Fairy ring and Mushrooms	Fumigation is the only effective chemical control recommended. Usually occurs near or around decomposing organic matter. Removal of this material will help to eliminate the disease.		
Pink Snow Mold and Fusarium Patch (*Fusarium*)	*Tersan 1991 WP 50 Daconil 2787 Flowable *Easout 70 WP Arrest 75 W Caloclor WP Mersil WP Merfusan Du Rovral 50 WP PMAS	125 g 250-500 mL 125 g 250 g 90 g 125 g 1.25 kg 180 g 60 mL	For Fusarium Patch use 1/2 to 2/3 dose at first sign of disease in fall. Treatment consists of a single application late in fall before permanent snow cover.
Grey Snow Mold (*Typhula*)	Daconil 2787 Flowable Arrest 75 W Tersan SP 65% WP Caloclor WP Mersil WP Merfusan Du Rovral 50 WP PMAS	250-500 mL 250 g 175 g 90 g 125 g 1.25 kg 180 g 60 mL	Treatment consists of a single application late in fall before permanent snow cover.
Leafspot or Blight (*Helmintho-sporium*)	Thiram 80% WP Daconil 2787 Flowable Dyrene 50% WP Rovral 50 WP	125 g 95-190 mL 125 g 60 g	For preventive schedule spray 2 or 3 times, 1-2 weeks apart, beginning when first spots appear in early spring.
Powdery mildew	*Easout 70% WP	175 g	Spray when symptoms appear. Repeat in 2 weeks if necessary.

**Systemic, apply at intervals of 3-4 weeks. Alternate with one of the other products listed.*

CHEMICALS USED TO PROTECT ORNAMENTALS AND TURF

Name given in this publication	Other common or trade names
Ambush	(3) permethrin
APM	(5) azinphos-methyl, Guthion
Arrest	mixture of vitavax and thiram
Basamid	(2) dazomet
Benlate	(3) benomyl, Tersan 1991
Bordeaux mixture	prepared in spray tank from copper sulfate, hydrated lime and water
CAD	(2) Cadmium chloride
captan	(2) Orthocide C, Stauffer C
chlordane	(2) chlordane
Cygon	(2) dimethoate
Cyprex	(3) dodine
Daconil	(3) chlorothalonil, Bravo
diazinon	(2) Basudin
Dursban	(3) chlorpyrifos
Dyrene	(3) anilazine
Dylox	(3) trichlorfon
Easout	(3) Thiophanate-methyl
ferbam	(3) Fermate, Karbam Black — Chipman, Niagara
fixed copper	(3) Bartlett, Calsa Basi-cop, Spraycrop Tri-cop, Niagara
folpet	(3) Phaltan
Guthion	(5) azinphos-methyl, APM
Imidan	(3) phosmet
Kelthane	(2) dicofol
Lannate	(2) methomyl
lindane	(2) lindane
malathion	(2) malathion
maneb	(3) manzate D, Mantox, Dithane M-22
Meltatox	(3) dodemorph-acetate
metaldehyde bait	(3) metaldehyde
Meta-Systox-R	(2) oxydemeton-methyl
methoxychlor	(3) methoxychlor
Morestan	(3) Morestan
Orthene	(3) Acephate
Pentac Aquaflow	(2) Dienochlor
Pirimor	(2) pirimcarb
Plictran	(3) cyhexatin
PMAS	(2) Phenylmercury acetate
Polyram	(3) metiram
Quintozene	(3) Quintozene
Rovral	(3) iprodione
Sevin	(3) carbaryl
streptomycin sulfate	(3) Agri-Mycin
sulfur	(3) Green Cross, Bartlett, Chipman, Niagara, etc.
Tersan SP	(3) chloroneb
Tersan 1991	(3) benomyl
Thiodan	(2) endosulfan
thiram	(3) arasan, Chipman T, Niagara
Thuricide, Dipel	(3) Bacillus thuringiensis
Truban	(3) etridiazole
zineb	(3) Dithane Z-78, Parzate C, Green Cross, Stauffer, Niagara

The numbers within the brackets ( ) identify the Schedules in which the BRAND NAME products listed in this Table are classified under the Pesticides Act.

Explanation of Schedules

Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application on agricultural land.
Schedule 6	Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of Environment office nearest you.

ABBREVIATIONS

EC = emulsifiable concentrate	WP = wettable powder	F = flowable	Du = dust
SC = spray concentrate	SP = soluble powder	G = granules	°C = degrees Celsius
AP = agricultural powder	W = wettable (powder)	L = liquid	% = percent (by weight)

gram = g	metre = m	centimetre = cm	hectare = ha	millilitre = mL
kilogram = kg	kilometre = km	millimetre = mm	litre = L	hectolitre = hL
tonne = t				

NURSERY PUBLICATIONS

Publications* available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5, or from county or regional offices of the Ministry; or from the extension horticulturist serving your area.

29	*Drainage Guide for Ontario*
65	*Energy Conservation in Ontario Greenhouses*
75	*Guide to Chemical Weed Control*
162	*Turfgrass Diseases and Insect Pests* (Price $3.00)
313	*Mist Propagation*
334	*Rootstocks for Fruit Trees*
448	*Lawns*
483	*Pruning Ornamental Trees, Shrubs and Vines*
492	*Ontario Soils (price $1.00)*
501	*Farm Drainage*
505	*Ontario Weeds (price $2.50)*
515	*Farm Ponds*
529	*Weed Control in Lawns and Gardens*

FACTSHEETS

210/24	*Repair Grafting*
210/774	*Application Technique with Air-Blast Sprayers*
211/36	*Apple Rootstocks*
237/33	*Red Raspberry Cultivars*
240/18	*Nut Trees for Shade and Food*
270/31	*Sun-Shy Garden Plants*
270/542	*Fertilizing Trees and Shrubs in the Landscape*
273/24	*Growing Turf Grasses in Shade*
273/641	*Weed Killers for Lawns*
273/646	*Control of Crabgrass in Lawns*
273/646	*Controlling Native Creeping Bentgrass in Lawns*
274	*Ground Cover Plants*
275	*Trees in Our Environment*
275/17	*Native Trees of Ontario for Landscape Use*
275/22	*Planting Deciduous Trees*
275/24	*Preventing Fruit Formation on Ornamental Trees*
275/86	*Small Trees for Small Spaces*
275/636	*Common Disorders of Broad-Leaved Trees*
275/757	*Tree Wells and Retaining Walls*
276/17	*Shrubs in Home Landscaping*
276/636	*Juniper Dieback*
278/17	*Climbing Annuals*
278/18	*Broad-Leaved Evergreens for the Home Garden*
512	*Management of Organic Soils*
534	*Soil Acidity and Liming*
537	*Composts and Composting*
540	*Drainage Benefits*
557	*Farm Drainage Assistance*
557	*Understanding Drainage Assessment*
572	*Soil Erosion — Causes and Effects*
573	*Control of Soil Erosion*
573	*Grassed Waterways*

606	*Soil Fumigants*
626	*Hairy Chinch Bugs in Lawns*
628	*Soil & Root Sampling for Nematode Analysis*
628	*Nematode Control Guidelines for the Application of Soil Fumigants*
642	*Velvetleaf*
642	*Nutsedge*
744	*Weed Sprayer Calibration*
754	*Problems with Farm Ponds*
780	*Farm Workshops*

* *For complete list, including Factsheets, obtain most recent listing from source indicated.*

AGRICULTURE CANADA PUBLICATIONS

899	*Hedges for Canadian Gardens*
994	*Culture of Ornamental Trees for Canadian Gardens*
995	*Trees for Ornamental Planting*
1017	*Woody Climbers and Ground Covers for Canadian Gardens*
1168	*Transplanting Trees and Shrubs*
1289	*Fruit Propagation*
1364	*The Birch Leaf Miner*
1461	*Snow and Wind Control*
1505	*The Pruning Manual*

Available from Information Division, Agriculture Canada, Ottawa K1A 0C7.

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Weight — Volume Equivalents

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g ≈ 500 mL (0.50 L)
(0.10 kg) 100 g ≈ 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Dry — Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

METRIC EQUIVALENTS

LENGTH

inch	= 2.54 cm - 25.4 mm
foot	= 0.30 m
yard	= 0.91 m
mile	= 1.61 km

AREA

square foot	= 0.09 m^2
square yard	= 0.84 m^2
acre	= 0.40 ha

WEIGHT

ounce	= 28.35 g
pound	= 453.6 g
ton	= 0.91 tonne

PRESSURE

pounds per square inch	= 6.90 kPa

VOLUME (dry)

cubic yard	= 0.76m^3
bushel	= 36.37L

VOLUME (liquid)

fluid ounce (Imp.)	= 28.41 mL
pint (Imp.)	= 0.57 L
gallon (Imp.)	= 4.55 L
gallon (U.S.)	= 3.79 L

Temperature

°F = (°Cx9/5) + 32

°C = (°F-32) x 5/9

Approximate Application Rate Conversions

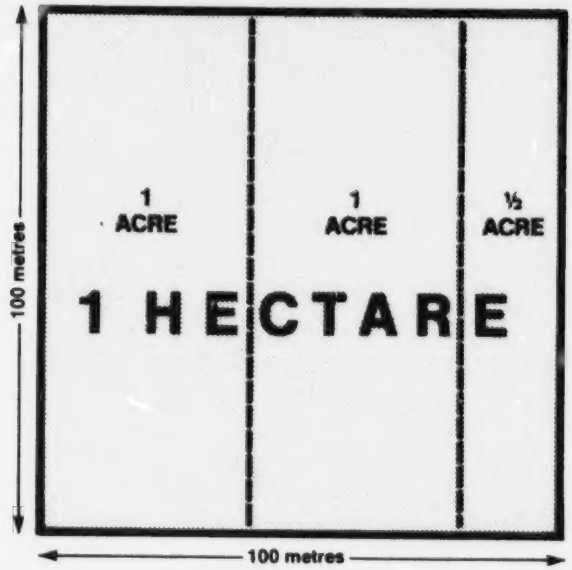
Metric to Imperial-

litres per hectare x 0.09	= gallons per acre
litres per hectare x 0.36	= quarts per acre
litres per hectare x 0.71	= pints per acre
millilitres per hectare x 0.015	= fluid ounces per acre
grams per hectare x 0.015	= ounces per acre
kilograms per hectare x 0.89	= pounds per acre
tonnes per hectare x 0.45	= tons per acre

Imperial to Metric-

gallons per acre	x 11.23	= litres per hectare (L/ha)
quarts per acre	x 2.8	= litres per hectare (L/ha)
pints per acre	x 1.4	= litres per hectare (L/ha)
fluid ounces per acre	x 70	= millilitres per hectare (mL/ha)
tons per acre	x 2.24	= tonnes per hectare (t/ha)
pounds per acre	x 1.12	= kilograms per hectare (kg/ha)
ounces per acre	x 70	= grams per hectare (g/ha)

ACRES BECOME HECTARES



100 m x 100 m = 10,000 m² = 1 hectare (ha)

HECTARES TO ACRES

1 hectare	=	2.5 acres
2 hectares	=	5.0 acres
3 hectares	=	7.4 acres
4 hectares	=	10.0 acres
5 hectares	=	12.4 acres
6 hectares	=	15.0 acres
7 hectares	=	17.3 acres
8 hectares	=	20.0 acres
9 hectares	=	22.2 acres
10 hectares	=	25.0 acres
20 hectares	=	50.0 acres
30 hectares	=	74.0 acres
40 hectares	=	100.0 acres
50 hectares	=	123.5 acres

ACRES TO HECTARES

1 acre	=	0.4 hectares
2 acres	=	0.8 hectares
3 acres	=	1.2 hectares
4 acres	=	1.6 hectares
5 acres	=	2.0 hectares
6 acres	=	2.4 hectares
7 acres	=	2.8 hectares
8 acres	=	3.2 hectares
9 acres	=	3.6 hectares
10 acres	=	4.0 hectares
20 acres	=	8.0 hectares
30 acres	=	12.0 hectares
40 acres	=	16.0 hectares
50 acres	=	20.0 hectares
60 acres	=	24.0 hectares
70 acres	=	28.0 hectares
80 acres	=	32.0 hectares
90 acres	=	36.0 hectares
100 acres	=	40.0 hectares

METRIC APPLICATION RATES WITH AN ACRE PERSPECTIVE

Dry Weight	
10 g/ha	= 4 g/acre
20 g/ha	= 8 g/acre
30 g/ha	= 12 g/acre
40 g/ha	= 16 g/acre
50 g/ha	= 20 g/acre
100 g/ha	= 40 g/acre
500 g/ha	= 200 g/acre
1000 g/ha	= 400 g/acre
1 kg/ha	= 400 g/acre (0.4 kg/acre)
2 kg/ha	= 800 g/acre (0.8 kg/acre)
3 kg/ha	= 1.2 kg/acre
4 kg/ha	= 1.6 kg/acre
5 kg/ha	= 2 kg/acre
10 kg/ha	= 4 kg/acre
20 kg/ha	= 8 kg/acre
30 kg/ha	= 12 kg/acre
40 kg/ha	= 16 kg/acre
50 kg/ha	= 20 kg/acre
100 kg/ha	= 40 kg/acre
500 kg/ha	= 200 kg/acre
1000 kg/ha	= 400 kg/acre
1 tonne/ha	= 400 kg/acre

Liquid Volume	
10 mL/ha	=4 mL/acre
20 mL/ha	=8 mL/acre
30 mL/ha	=12 mL/acre
40 mL/ha	=16 mL/acre
50 mL/ha	=20 mL/acre
100 mL/ha	=40 mL/acre
500 mL/ha	=200 mL/acre
1000 mL/ha	=400 mL/acre
1 L/ha	=400 mL/acre (0.4 L/acre)
2 L/ha	=800 mL/acre (0.8 L/acre)
3 L/ha	=1.2 L/acre
4 L/ha	=1.6 L/acre
5 L/ha	=2 L/acre
10 L/ha	=4 L/acre
20 L/ha	=8 L/acre
30 L/ha	=12 L/acre
40 L/ha	=16 L/acre
50 L/ha	=20 L/acre
100 L/ha	=40 L/acre
500 L/ha	=200 L/acre
1000 L/ha	=400 L/acre